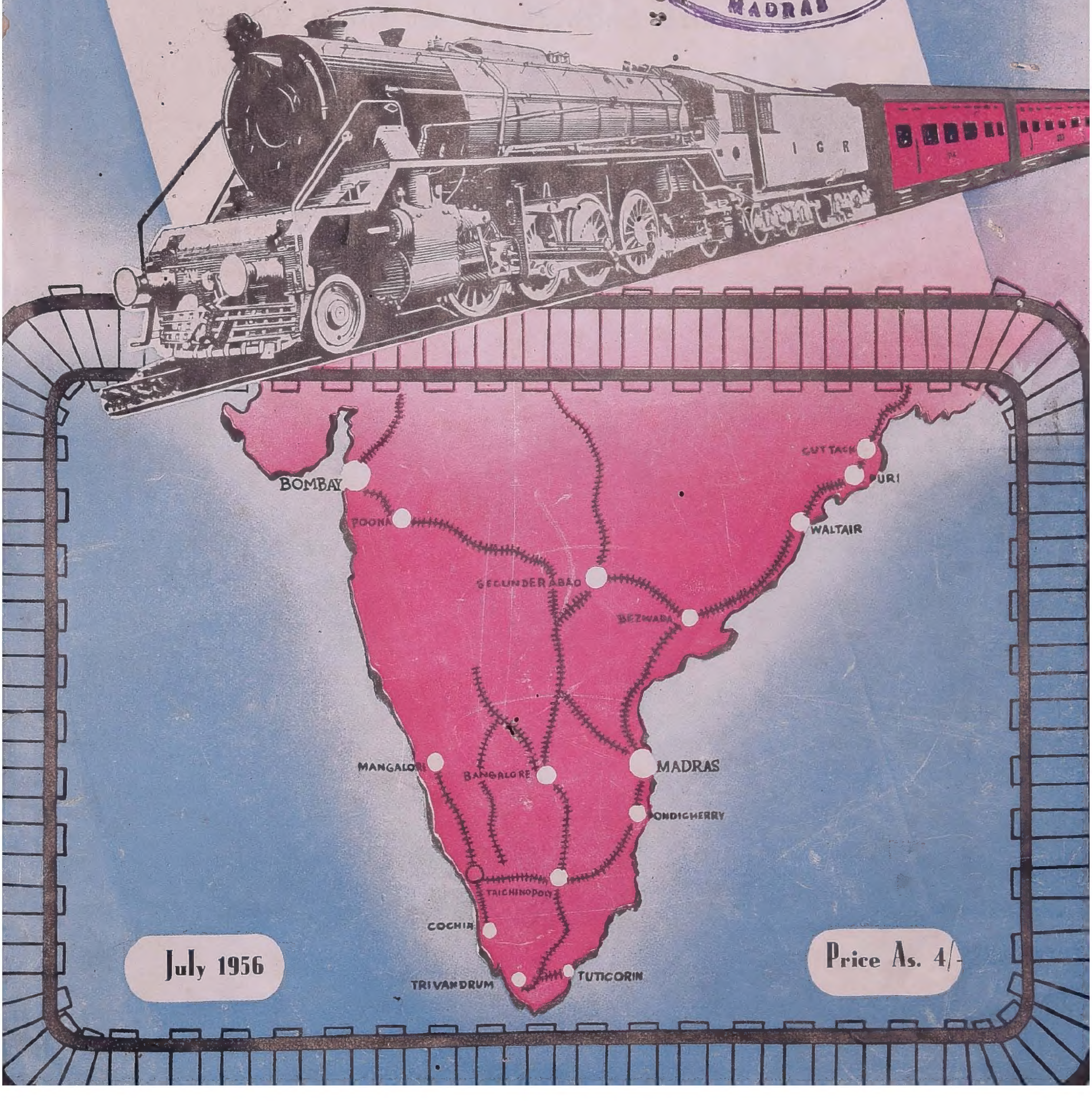
Annual Number Cum Engineering Supplement

SOUTHERN RAILWAYS *Magazine*



July 1956

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Editorial Notice

The Editor invites contributions to the Magazine on a variety of topics—short stories, technical features written in simple English understandable to the laymen, Aspects of Railway Working, places of tourist interest, News from home line, activities on Railway Institutes etc. All copy should be brief and typed as far as possible.

Photographs illustrating social functions, sports events, scenic sports etc. are also invited. All contributions should reach the Editor not later than 5th of each month. Rejected Mss. will be returned provided sufficient stamps for postage are enclosed. No responsibility will be borne for copy lost in transit.

Views expressed in this Magazine should not be taken as having official authority.

All correspondence should be addressed to the Editor, "Southern Railways Magazine," Post Box No. 17, Tanjore, (South India).

THE HEY-BACK RAIL FASTENING

BY

THE WORKINGTON IRON AND STEEL COMPANY

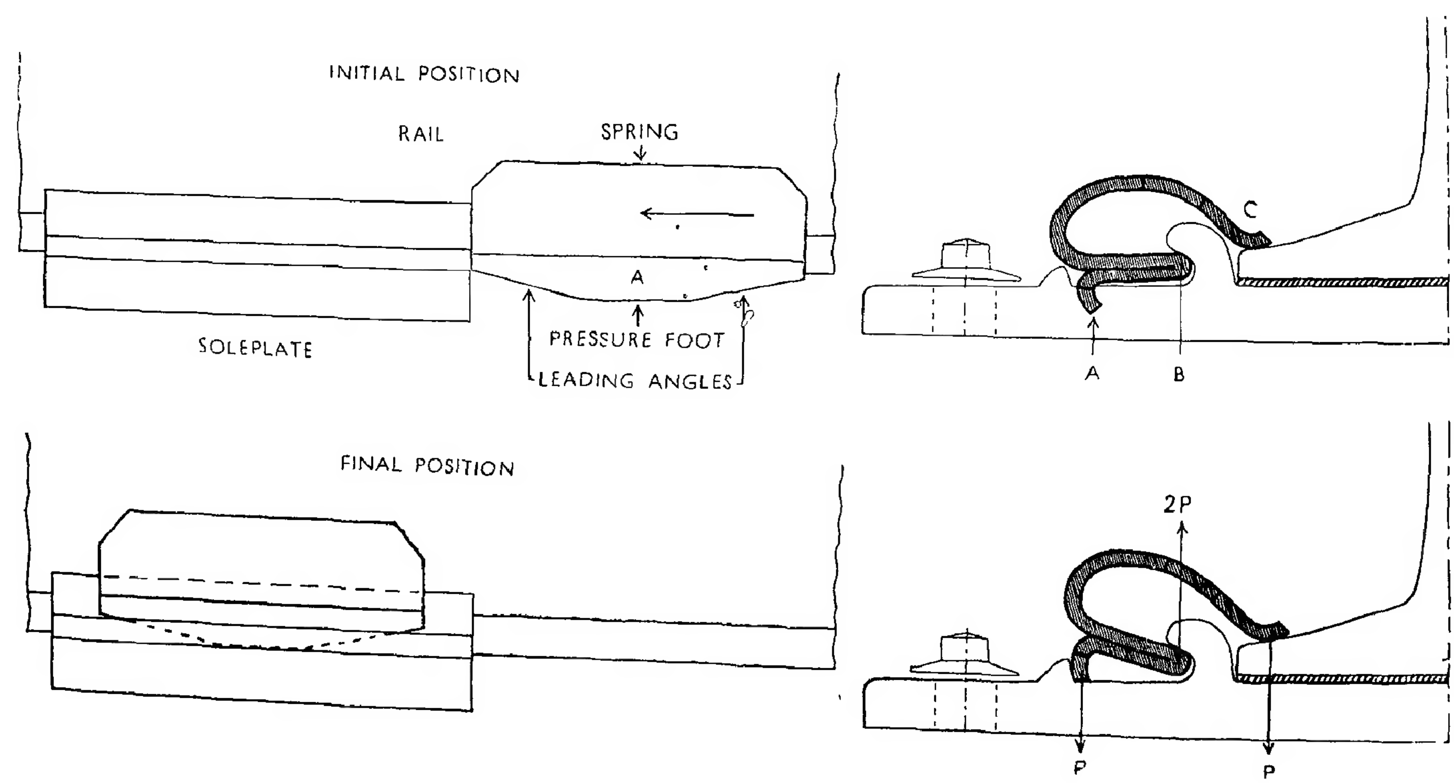
(BRANCH OF THE UNITED STEEL COMPANIES LIMITED, SHEFFIELD, ENGLAND)

This recently developed system of elastic yet rigid rail fastening may be of interest to all those concerned with track-work problems.

THE development of the system took place in Norway where railway engineers first took out patents in 1942. Subsequently the war years put a brake on progress and it was not until 1949 that production commenced on a commercial scale. Now the System is standard on the Norwegian State Railways and is giving every satisfaction. It behaves admirably on tracks subject to a wide temperature variation from season to season and has allowed the reduction of time spent on maintenance and inspection. Not possessing the necessary manufacturing facilities Norway turned to Great Britain for the production of the rolled steel soleplate which is the heart of the system. In this way it was brought to the attention of British Railway engineers. The first experimental length of track in Britain was laid in 1950 in a heavily worked main line near New Cross Gate on the Southern Region of British Railways. Preliminary results being encouraging, a further trial stretch was laid at Neasden by the London Transport Executive, who have now placed a second order. The Southern Region are likewise extending their use of the system and have ordered a further 20 miles of track. Further afield, the South African Railways have planned an experiment which will utilize the Hey-Back system. The system's fitness for use under arduous industrial conditions will be proved shortly by a full scale section of track in the largest steelworks in the British Commonwealth, the Appleby-Frodingham Steel Company, England. Thus under varied traffic and climatic conditions the Hey-Back system is proving itself to the railway world.

A striking feature of the system is that it gives the track engineer so many advantages yet it is simple in the extreme. Two special components are involved, the grooved soleplate and the pressure spring.

The soleplate is produced in rolled steel. The weight compares very favourably with other types of soleplate used with flat bottom rails. For wooden sleepers it is rolled with the required tilt, but for concrete sleepers, where the tilt can be incorporated in the casting of the sleeper, the soleplate can be rolled without tilt, of even thickness, thus considerably reducing the weight per



unit. The soleplate is secured to the sleeper by conventional methods, coach screws or bolts for timber, and bolts or coach screws for concrete, when special resilient sockets can be used. The soleplate is fastened to the sleeper with or without a resilient pad as a seating.

It is equally well adapted to assembly at track preparation depots or for minor renewals on site. Once fixed to the sleeper, the soleplate need never be disturbed during the life of the sleeper.

The spring clips, two per soleplate, are of special design and extremely simple to assemble. They slide into the prepared grooves in the soleplate, being easily entered by hand from either side of the plate and then driven home with the customary keying-hammer. Two leading angles on the clip facilitate entry and as the clip is driven home the spring action comes into operation (see diagram). As the wedge section 'A' is forced into the groove, the projection at 'B' acts as a fulcrum causing the clip arm at 'C' to bear strongly downwards on the flange of the rail. It will be noted from the diagram that the pressure causing friction between the spring clip and the groove is three times greater than that between the clip and the rail.

The function and behaviour of the components in the track under load is such as to eliminate creep.

The spring pressure on the rail flange is independent of the fastening of soleplate to sleeper and it does not depend on correct adjustment of bolt nuts, etc., or of the firmness of the 'grip' in the sleeper. This gives several advantages.

Vertical movement of the rail under a rolling load is permitted without any risk of reduction of spring pressure. The holding-down pressure is constant on every fastening at all times. The sleeper itself will normally attempt to move before relative movement between rail and soleplate occurs. The rail and soleplate are held firmly together irrespective of the condition of the sleeper and whether or not pads are used between rail and soleplate. The positive fastening of rail to soleplate prevents widening of the gauge.

The system thus is vertically flexible and shock-resisting and it keeps transversely stiff irrespective of radius of curve. In other words, it complies with the theoretical conditions laid down for the fastening in connection with heavily loaded, high speed traffic. These conditions are even more important in connection with use of long welded lengths of rail.

The advantages are similarly apparent in connection with concrete sleepers. Cast-in rubber or other sockets for soleplate coach screws and independent, flexible fastening of rail to soleplate reduce the strain on the 'dead' concrete. The system does not depend on 'anchoring' in the body of the concrete sleeper for maintenance of spring pressure and of gauge.

For those concerned with the metallurgical aspects of railway equipment it may be of interest to note these details about the materials used to manufacture the components. The soleplates are made of 26/32 tons per square inch tensile strength steel to British Standard Specification No. 751 of 1937, or to any other agreed specification. The spring clips are made of silico manganese, carbon chrome manganese or other spring steel suitably hardened and tempered so that the eventual hardness of the springs is Rockwell No. 41 to 45. The springs are made to such a dimension under the pressure point that when they are fitted into the soleplates over the rail foot a calculated pressure is applied to the rail foot. A typical holding-down pressure is 1,200 lbs. per spring.

When deciding the pressure it should be borne in mind that every spring clip maintains a constant pressure all the time. It is, thus, unnecessary to start off with a safety margin to allow for a gradual decline of pressure as is often the case if the fastening depends on the "grip" in the sleeper being maintained. Further, it is obvious that undue stresses in the track may more easily occur if the holding-down pressure is great on some fastenings and small on others.

One feature in the design of the Hey-Back Fastening is that it keeps to a minimum any modification of existing track or methods. It represents a technical advance in design without the serious initial inconveniences usually involved in superceding established standards.

The Hey-Back Fastening also benefits the permanent-way engineer by cutting down to a minimum the time required for rail renewals; at points of high traffic density or where tunnels are numerous the great speed with which rails can be removed and changed makes it a valuable contribution to track maintenance problems.

Finally from the point of view of safety and simplicity the Hey-Back rail fastening represents a solution to the problems of track design which undoubtedly are influenced by the trend towards increasing lengths of rails as well as increasing speed and axle-load. However rapidly modern methods of locomotive propulsion are extended, the main demand of the track designer is 'safety first'.

A Review of the Respective Merits of the Solid and the Built-up Rolled Steel Wheel

By C. F. Ryan, M. B. E., A. M. I. Mech. E., M. I. Loco. E.
Chief of Development, Railway Materials, Steel, Peech & Tozer.
(BRANCH OF THE UNITED STEEL COMPANIES LIMITED, SHEFFIELD, ENGLAND)

THE solid rolled steel wheel has come into increasing use on railways in all parts of the world during the past twenty-five years and it is worth nothing that during the past eight years. British manufacturers have sent a total of 13,750 pairs of solid wheels to India. At the present time solid wheels are used almost exclusively on new wagons for British Railways and have proved satisfactory on London Transport Executive trailer cars. In South Africa and Australia both carriages and wagons are being equipped with this type of wheel. The Swiss railways have standardised on the solid wheel for their international coaching stock and for electric motor coaches and trailers; in Spain it is being fitted to carriages and to electric motor coaches and rail cars. In the United States and Canada, the solid wheel has been adopted for all new rolling stock, including diesel locomotives. These are only some of many examples demonstrating the fact that the solid wheel has become a standard item of equipment on many systems and it is interesting to make an impartial study of the causes which have led to the adoption of the solid wheel under such a wide variety of service conditions.

Before deciding on the most suitable type of wheel for a particular class of rolling stock the designer will naturally consider the conditions under which the stock will have to work. In making the decision the following factors will be borne in mind:

(a) Reliability
(b) Effect of wear
(c) Availability of repair facilities
(d) Saving of weight
(e) Cost and estimated life.

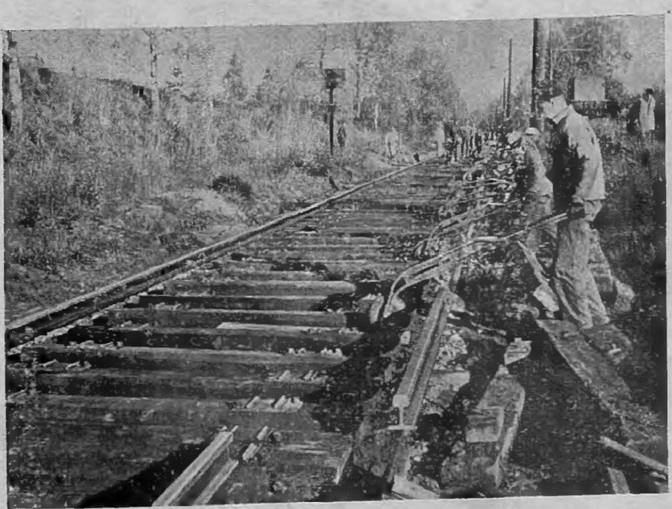
(a) *Reliability*

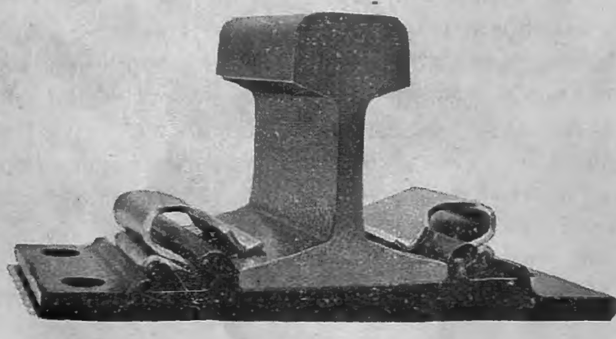
Reliability, or freedom from defects, is a most important consideration. It is difficult to assess the value of this quality in terms of money since the consequences of any one failure may be serious or trivial—a major derailment or a few minutes' delay. With the built-up wheel there is always the possibility of a loose tyre and danger, admittedly slight, of a broken one. Cases of fractured solid wheels have been known but they are extremely rare.

At least one important railway has found that there is less tendency to flaking or shelling of the surface of the tread in the case of solid than in that of built-up wheels; this they attribute to the fact that with solid wheels the rolling surface is not subject to shrinkage stresses.

With the built-up wheel some trouble may be experienced due to corrosion between the wheel rim and the inner surface of the tyre although there is less likelihood of this when these two surfaces have been given a good finish during machine.

(Continued on page 6)





(Photographs by courtesy Norwegian State Railways)

In general, so far as reliability is concerned, the advantage lies with the solid wheels.

(b) *Effect of Wear*

Where service conditions are such that heavy wear takes place the built-up wheel may prove the better choice from an economic point of view. If, however, there are a number of long and severe gradients on the system and the wheels are braked, the danger of loose tyres may alter the balance in favour of the solid wheel. Similarly, for suburban service applications, where traffic requirements demand frequent starting and stopping with rapid acceleration and deceleration, the tyre wear will be heavy but the same danger of loose tyres will exist.

Under such conditions it may be worthwhile considering the possibility of using a solid wheel in the first place and subsequently turning it down and fitting a tyre as is done on several railways, but it is suggested that this procedure should not be adopted unless a very careful analysis of the economic and other factors involved shows it to be justified. Labour costs will vary widely between different countries and accountancy methods between different railways. It will generally be found that the saving, compared to the purchase of a new solid wheel, is small and at best this practice is only a compromise. If the solid wheel were chosen in the first place because of its inherent advantages these advantages will now be lost and the resulting tyre and disc may not even be as satisfactory as an ordinary built-up wheel.

(c) *Availability of Repair Facilities*

The general availability of repair facilities has some influence on the choice of wheel. Built-up wheels require equipment for removing worn tyres, machining wheel rims, and the fitting and turning of new tyres. Solid wheels only require re-turning; when they come to the end of their useful life, which, except in the case of the A.A.R. one-wear wheel, is very considerably longer than that of a tyre, they have to be pressed off the axle. The wheel seat will probably require skimming up after the wheel has been pressed off, although even this may be avoided in some cases if the oil-injection method, whereby a thin film of oil is created between the wheel seat and the bore of the wheel, is used.

The fact that the wheel never has to be removed from the axle is a definite advantage in favour of the built-up wheel. This particular advantage may be nullified by having a solid wheel which, on reaching the limit of wear, can be turned down to take a tyre but, as has already been suggested, the economics of the various alternatives should be carefully studied before this design is adopted.

(d) *Saving of weight*

The modern tendency in rolling stock design is to reduce the tare weight as much as possible. This is particularly important in the case of wheels since, in addition to the contribution that they make to the tare weight of the vehicle, account must also be taken of the kinetic energy due to rotation which is built up during the acceleration of the vehicle and dissipated during braking. Furthermore, any reduction of the unsprung weight, of which the wheel constitutes a considerable proportion, has the further advantages of reducing the wear on the track and improving the riding of the vehicle.

In general a solid wheel tends to be lighter than the corresponding built-up wheel and this is, of course, a marked advantage of the one-wear type.

(e) *Cost and Estimated Life*

The two remaining factors, cost and estimated life, may logically be considered jointly. The first cost of a broad-gauge solid wheel is less than that of the corresponding built-up type by about Rs. 135/- per wheel; for metre-gauge wheels the difference is about Rs. 100/-. Under identical conditions of service the solid wheel will have a considerably longer life than a tyre. For two wheels of equal rim thickness, one solid and the other built-up, the difference in total wear is represented by the scrapping thickness of the tyre, which is seldom less than one inch. In the paper which Mr. C. A. Gammon read to the Institution of Locomotive Engineers, in April 1950, on the standardisation and design of goods and mineral wagons as applied to British Railways, he stated that the life of a solid wheel would be about thirty years and, in the course of the subsequent discussion, he indicated that with built-up wheels the tyres would require renewal after approximately fifteen years. These figures are quoted to give an indication of the relative length of life of the two types.

Where tyre wear is heavy and repair costs are low it may prove more economical to re-tyre the wheel so as to get a good life from the centre; but under average service conditions the lower first cost of the solid wheel, combined with normal life and higher scrap value, will give it the advantage.

For overseas railways in particular the question of the total cost of wheels held in stock is an important one; the exact quantities held will, of course, depend on circumstances but the considerably shorter life of the tyre will necessitate holding of larger stocks. These may well exceed in value the smaller stocks of solid wheels that would be held for the same purpose.

CONCLUSION

The trend of modern design definitely favours the solid wheel and the production figures for solid and built-up wheels at the mills of Messrs. Steel, Peech & Tozer provide a convenient yardstick. The figures for the past twenty-five years are tabulated below and clearly demonstrate what a big change-over has occurred. It should be stressed that these figures cover production for all parts of the world.

Year ending June	*Percentage Solid Wheels*	*Percentage Disc Centres*
1931	20.0	80.0
1932	16.0	84.0
1933	34.0	66.0
1934	61.0	39.0
1935	61.0	39.0
1936	76.0	24.0
1937	77.0	23.0
1938	75.0	25.0
1939	80.0	20.0
1940	79.0	21.0
1941	94.6	5.4
1942	98.0	2.0
1943	96.3	3.7
1944	95.6	4.4
1945	97.2	2.8
1946	94.0	6.0
1947	92.8	7.2
1948	94.2	5.8
1949	92.3	7.7
1950	90.3	9.7
1951	92.6	7.4
1952	95.5	4.5
1953	96.5	3.5
1954	97.3	2.7
1955	97.6	2.4

MODERN DEVELOPMENT IN RAILWAY ELECTRIFICATION

RECENT years have seen remarkable progress in the field of Railway Electrification and particularly is this so in the application of the high voltage A. C. system at the industrial frequency. Successful pilot schemes in France and England have clearly demonstrated how the earlier limitations of the 50 cycles per second frequency current may by the use of new materials and ingenuity of electrical design not only be overcome at the locomotive but may yield substantial advantages in the simplification of substation layout and feeder system. The measure of success achieved can be seen in the successful introduction in post-war years of high voltage 50 cycles schemes in Turkey, the Belgian Congo and France and the decisions to proceed with such schemes in France, Great Britain and Portugal.

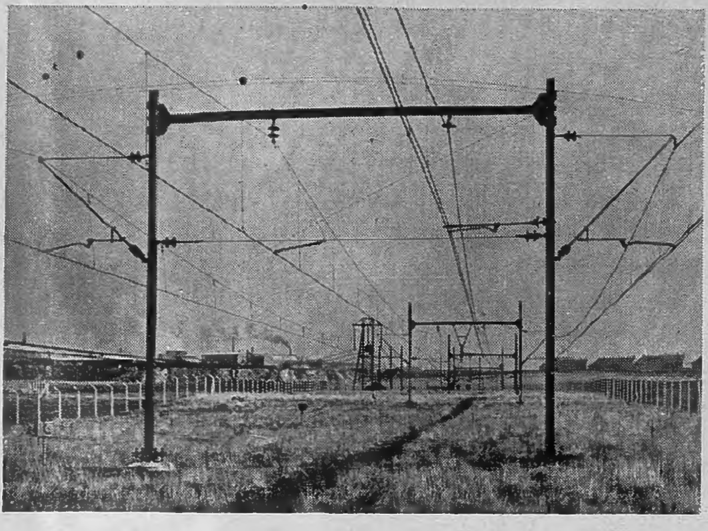


Fig. 1. A general view of the experimental station at Rye Hey.

Parallel with these striking developments, the B. I. C. C. Organisation has undertaken a large scale experimental programme with the object of applying the results of modern research to the improvement of the overhead contact system. In this way it has been possible to study the behaviour of the types of light conductor construction required for high voltage systems so that the equipment, when installed, will give good current collection upto very high speeds while at the same time yielding a saving of nearly two thirds of the copper section normally necessary for a 1500 volt D. C. scheme. The design of the associated fittings has been equally advanced with the object of reducing weight to a minimum, ease of erection and maintenance and freedom from corrosion problems when in service. Not least has been the degree of mechanisation applied to the excavation and concreting for the supporting structures which has revolutionised the technique of structure erection and now permits one mile of single track to be equipped with masts in a line block of four hours. Some of the features of this work are later described in greater detail.

RYE HEY RESEARCH STATION

At an early stage it became apparent that in addition to running trials of the overhead equipment it would be necessary to carry out much experimental work that would require access to the overhead equipment for long periods at any hour of the day. This facility is rarely, if ever, available with equipment erected over railway tracks in normal operation and for this reason it was decided to establish a Research Station on open land at which many different types of contact systems could be installed and studied with complete freedom from restrictions. The general view of the station (Fig. 1) illustrates this point and shows four of the first types of equipment selected for investigation.

One of the main objects has been to study the variations within the overhead equipments caused by changes of weather. A contact system in perfect adjustment for current collection under one set of temperature and wind conditions. These changes are brought about by variations in the tensions, heights, lengths and temperatures of the wires and alterations of the load distribution.

The first of these features is clearly seen in Fig. 2. This equipment was composed of a 7.116″ copper catenary wire supporting by means of "suspenders" or "dropper wires" a 0.166 sq. in. cadmium copper contact wire. Both contact and catenary wires were anchored at fixed points and it may be observed how the daily temperature cycle produces small tension fluctuations in the catenary but very substantial fluctuations of contact wire tension. This type of equipment erected under Indian climatic conditions would be suitable only for slow speed running. Even variations in the light loads carried by the dropper wires may have a great effect and Fig. 3 illustrates the miniature hydraulic

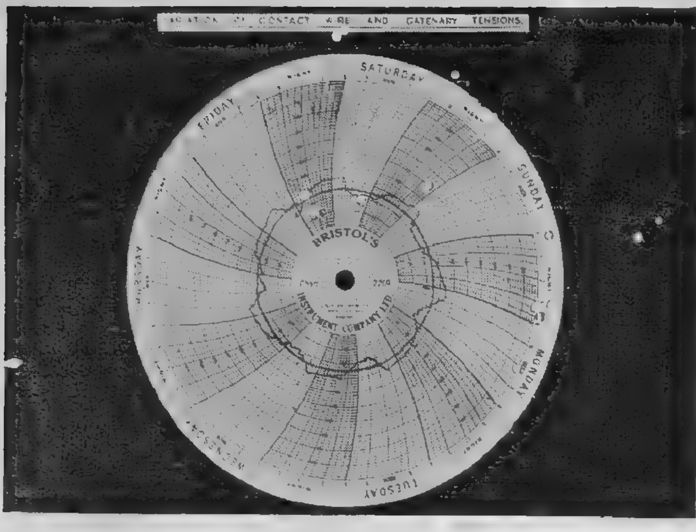


Fig. 2. A chart showing the daily variation of catenary and contact wire tensions.

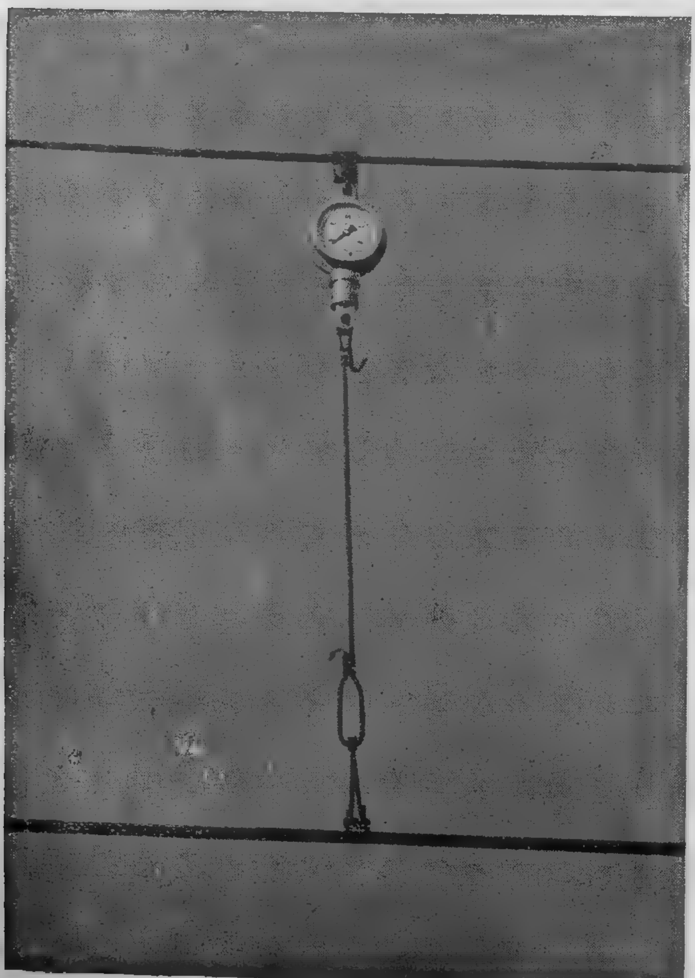


Fig. 3. Miniature dynamometer specially made for measuring the load in the dropper wires which support the contact wire from the catenary.

dynamometer which was specially built to study this problem.

The influence of wind may be judged by a comparison of figures 4 and 5. The former indicates the variations in the height of the contact wire at different positions along its length during a seven day period without wind while in the latter illustration may be seen the severe oscillation caused by gale-force winds on the sixth day of a similar test period.

LANCASTER–MORECAMBE–HEYSHAM ELECTRIFIED LINE

Complementary with the research programme briefly referred to, a section of the Lancaster-Morecambe-Heysham electrified line was with the kind of co-operation of British Railways completely re-equipped with overhead equipment of the most modern design. This electrification is a high voltage A.C. scheme and was converted in 1952 from 25 cycles/sec. to 50 cycles/sec. operation. The opportunity was taken to demonstrate the use of six different type of aluminium, steel concrete and wood supporting structures and many variants of insulators, droppers, clips, switches and other fittings were installed. Electronic records of current collection at high speed were taken to test the methods of suspension adopted and on no occasion was it possible to detect any break in contact between the pantograph and the overhead conductors. This was in marked contrast to the performance on sections of the much older type of equipment previously existing which as the record of three test runs in figure 6 illustrates indicated a serious deterioration in current collection as the speed of the train was increased.

To obtain this high quality of performance the conductors were designed to be automatically tensioned by terminating wires passing over pulleys and supporting balance weights. In this manner any change in length of the conductors is compensated by movement of the balance weights and the tensions remain constant. The arrangement may be seen in figure 7 which shows a self-supporting steel anchor mast alongside one of the old wooden structures which supported the original equipment.

THE WOODHEAD TUNNEL TRIALS

The electrical security of an overhead line is as vitally important to the success of a scheme as its mechanical performance and this is particularly so at high voltages of the order of 25 kV. Many types of insulator varying greatly in cost and electrical strength may be employed

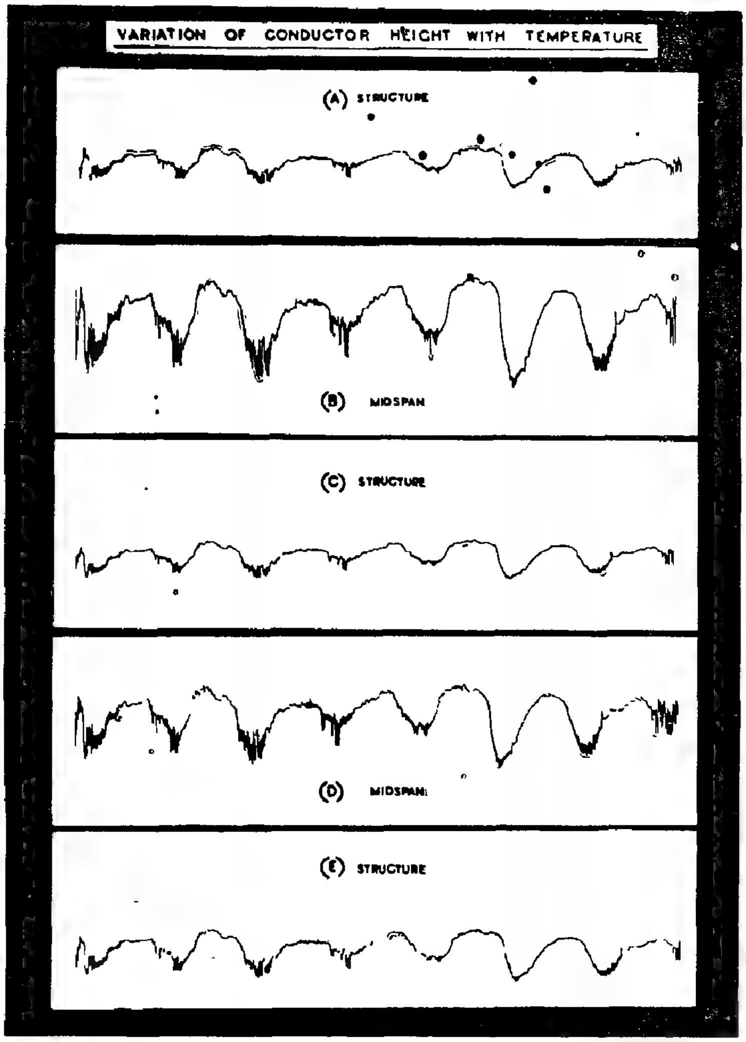


Fig. 4. Records taken from five height recording instruments placed on various points along the line and presenting a complete picture of the movement of the contact wire caused by variation of temperature.

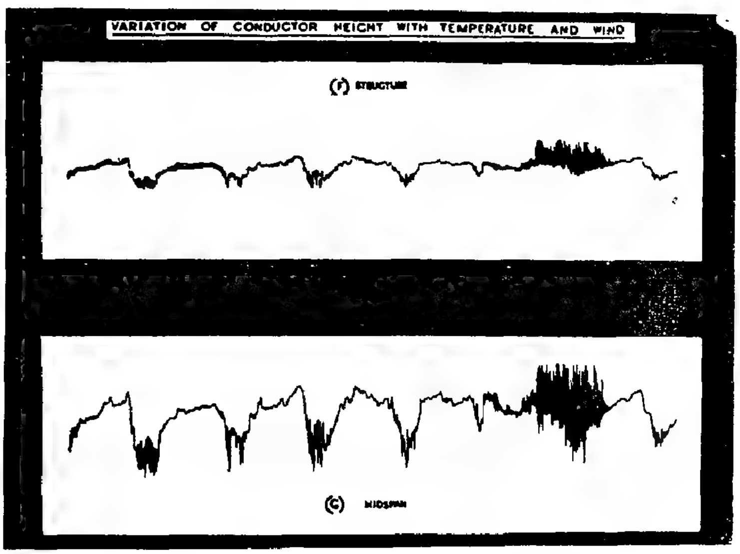


Fig. 5. Two similar records showing the effect of variations in wind pressure as well as variations in temperature.

in both clean and polluted atmospheres. Where steam operation is likely to be encountered after electrification a higher level of insulation must be used than would be required on lines without steam traffic. A commonly accepted direction for the latter is to provide a length of leakage path across the insulator surface of 1 inch per kV. of the voltage which would exist between phases on an equivalent 3-phase system i. e. for a 25 kV. single phase A.C. system the creepage path required would be $25 \times \sqrt{3} = 44$ inches. The insulator must therefore be designed to maintain a high level of insulation even when wet and dirty, to be easy to clean and to require only occasional cleaning, while also possessing the adequate strength to carry the mechanical loads imposed by the part played by the insulator in supporting the conductors.

With these thoughts in mind, 32 insulators of different types were installed above the running track in the Woodhead Tunnel on the Manchester-Sheffield line. This tunnel is some three miles in length on a steep gradient and before electrification carried a heavy mineral traffic. Due to its age and poor ventilation the atmosphere was often very bad and it therefore seemed an ideal location to carry out a study of insulator perfcrmance under adverse conditions. The Insulators which were flashover and resistance tested at regular intervals included types protected by cowls and others with oil-bath protection. This series of tests extending over many months yielded much useful information that is now being used when considering designs for future work.

MECHANISATION OF INSTALLATION

The speed with which the overhead equipment contractor is able to install the equipment on any scheme is very largely dependent on the duration of the track occupation which is granted to him. Naturally such blocks cause inconvenience and necessitate modifications to train time-tables. Since lines scheduled for conversion to electric operation are however usually amongst the most heavily loaded it is essential that any line blocks should be kept to a minimum to avoid serious traffic delays. These requirements are unfortunately mutually opposing and the compromise reached may well influence the cost of a new installation.

To meet this situation British Insulated Callender's Construction Company Ltd., in co-operation with Wharton Engineers Ltd., devised and manufactured mechanical equipment which enables the structure foundations to be dug, side masts erected and concrete

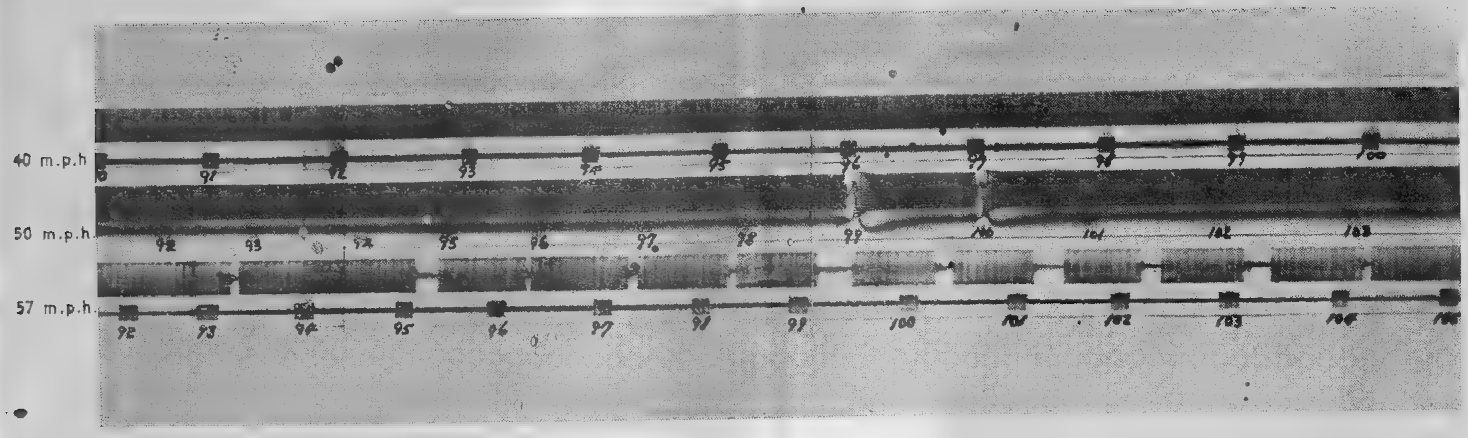


Fig. 6. Part of the electronic records of contact between the collector and the contact wire on the Lancaster–Morecambe–Heysham Railway. Each break in the trace indicates a loss of contact between pantograph & the overhead conductor.

Fig. 7. Self-supporting steel anchor mast carrying balance weight termination of new equipment.

poured at the rate of ten minutes per mast for all these operations. This rate of installation much reduces the total time previously required for this section of the work, utilising hand excavation.

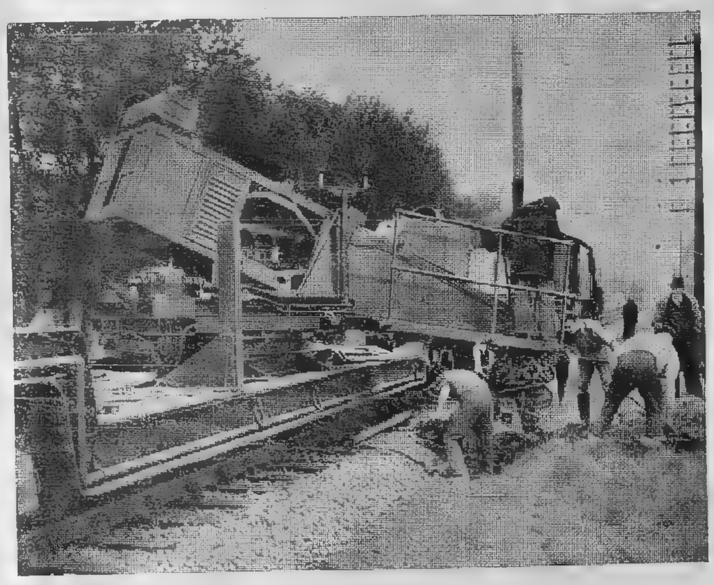


Fig. 8. In this picture the auger is operating at normal boring distance from the rails. The spoil is removed by lifting the auger periodically from the hole and is then flung out by centrifugal force. Distribution of this spoil is carried out by hand.

Each hole is bored by a rail mounted auger. This is followed by a steel erection unit which erects the mast supported by a temporary ground frame in the hole. Following in sequence the concreting unit places the concrete, which has been mixed on the train, into the foundation. As each operation is completed the three units move in turn to the next location. In this way, rapid progress is made and as the operations proceed simultaneously only one track occupation period is required for the three units. There is no waste of concreting materials and foundations need no longer be as large as were previously required to permit manual excavation.

Fig. 9. Concrete placer unit in operation. The bogie wagon also carries the two rotary concrete mixers.

The earth borer (fig. 8) can excavate foundations down to 12 ft. depth with a variation in bore diameter of from 2 ft. to 3 ft. 6 inches. With a maximum reach from the centre line of track of 13 ft. 6 inches lineside obstacles such as drains or cables may be safely cleared. The concreting unit (fig. 9.) incorporates two electrically driven mixers, an electro-hydraulic placer unit with a telescopic jib and a diesel-electric power generating unit. The continuous supply of concrete from the mixers prevents any hold-up occurring and the placer unit is so designed as to be able to convey the concrete directly to the foundation holes without excessive train shunting.

The application of such a high degree of mechanisation to foundation installation results in big savings of time and materials and has been used with distinct success.

LOOKING TO THE FUTURE

At the present time world-emphasis is naturally centred on the great progress made with high voltage 50 c. p. s. A.C traction because the savings possible on the fixed installations with this system may reduce the capital costs of an electrification scheme and may also justify the extension of electrification to more lightly loaded lines. The background to this progress lies in the long programmes of trial and development and the resourcefulness of engineers skilled in this field which alone makes such steps possible.

Mention has been made of a number of the more notable advances made by B. I. C. C. in the field of railway electrification. But the work does not end there. Development is a continuous process in which advantage is taken of new scientific processes and improved techniques in the factory and in the field to produce a high performance, trouble free overhead contact-wire network.

CENTRAL RAILWAY LAUNCHES DRIVE AGAINST MEN TRAVELLING IN LADIES' COMPARTMENTS

THERE has been an increasing tendency for men to travel in compartments reserved for ladies in the Bombay suburban area. It is an offence under Section 119 of the Indian Railways Act, for men to travel in compartments reserved exclusively for ladies and under Section 131 of the same Act, a person committing an offence under Section 119 is liable to be arrested even without a warrant. The apprehension of such offenders is being done both by the Police and by the Railway and their prosecution are launched under these provisions of the Law by the Police.

The average of such prosecutions done of persons apprehended by the Central Railway in 1955, in the Bombay suburban area was 13 a month. A drive against men travelling in ladies' compartments has recently been launched and as a result of this drive, 88 persons were prosecuted in April 1956. A further intensification of this Railway's drive has been made with a view to check this evil. In the last three days of May 1956, no less than 107 persons were apprehended by the ticket-checking and security staff of the Central Railway for travelling in ladies' compartments over the suburban section in the Greater Bombay area. They were handed over to the Railway Police by whom they were prosecuted. Convictions were secured in all cases and the sentences ranged from warnings to fines extending upto Rs. 10/- or simple imprisonment ranging from 1 to 5 days.

These figures do not take into account numerous prosecutions launched by the Police on their own initiative. This being a cognizable offence, no complaint is required by the Police from the Railway for the apprehension and prosecution of offenders under this Section of the Railways Act.

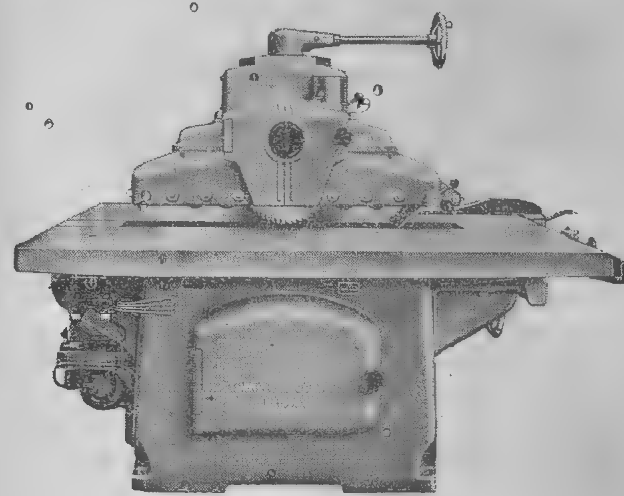
RECENT DEVELOPMENTS IN THE DESIGN OF WOODWORKING MACHINERY

ALTHOUGH it is true to say that within the last ten or fifteen years there has been an increasing tendency to use metals and plastics for articles formerly made from wood, there is no danger of wood either in its natural form or in processed form, being completely replaced by these substitutes. Timber is readily available in most countries, is easily extracted, easily machined, has fairly good mechanical properties and has a natural beauty which defies imitation.

The economic manufacture of wood products calls for a high degree of mechanisation and today all cutting and abrading operations on wood can be carried out entirely by machinery, man only being required to control the machines and to feed them.

The basic cutting principles of Woodworking Machines have been established for many years. These basic cutting operations consist of sawing by means of Circular Saws, Bandsaws or Reciprocating Saws, planing or dressing the faces of the cut timber by means of rotating square or circular Cutterblocks carrying Planing Knives, mortising with chisels or cutter chains and surface finishing by means of abrasive coated paper or cloth applied to the timber either in the form of flat belts or rotating drums.

The main developments in recent years are in the application of these basic cutting principles. The designer's aim has been to combine quality of work produced from the machine with maximum output. To achieve this end he has had to take advantage of the latest developments in pneumatics and hydraulics. Oil hydraulics provide a simple means of obtaining infinitely variable speeds over a wide range applied either to reciprocating or rotary motions. For example, on the latest "White" Vertical and Horizontal Band Mills the forward and return motions of the Log Carriages are controlled by Vickers-Armstrong hydraulic variable speed gear units. This unit enables the sawyer to select quickly any desired feed speed on the forward stroke up to 80 ft. per minute and on the return stroke up to 200 ft. per minute. An example of the application of hydraulics to a rotary motion is to be found on the "White" Trufeed Straight Line Edger, Type SJ/B, (see illustration). In this case a Carter type Self-Contained Hydraulic Pump and Motor is used for driving the feed chain that carries the work through the machine. When a conventional type of

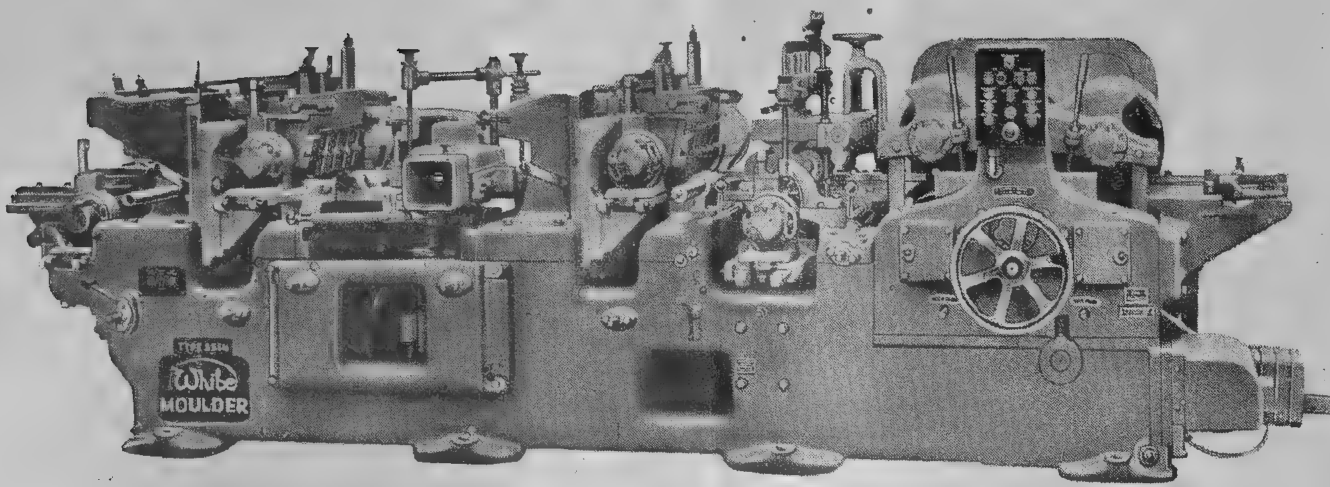


'Trufeed' Straight Line Edger Type SJB.

gear box is used with a Straight Line Edger the operator can only choose one of four or possibly six feeding speeds over the entire range. It is more than likely that the speed he selects will either be too fast to enable him to feed the wood through the machine end to end, or alternatively, too slow to ensure maximum output. With the Trufeed Edger, however, the operator can select the most suitable feed speed for each particular job and what is more, the actual feeding speed is clearly indicated on a Tachometer located at the operator's working position.

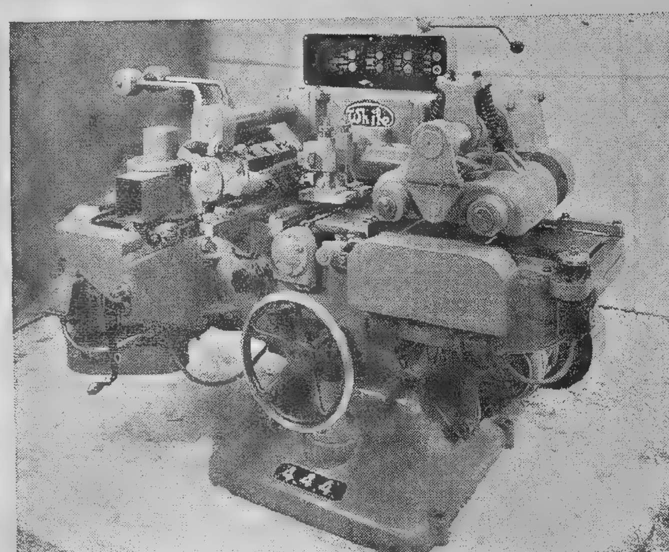
Pneumatics are now being used extensively for quick clamping of components as well as for the reciprocating motions on Crosscut Saws. Hydraulics are, of course, also used for Cramping Machines and for Straight Line Crosscut Saws, but where compressed air is normally available in a factory it will usually be found to be initially less expensive to employ pneumatics for these purposes rather than hydraulics.

The electrical manufacturers are also playing their part in the development of Woodworking Machinery. Many types of Woodworking Machines now have the motors built directly on to the Cutter Spindles. On single and double end Tenoning Machines where the Cutter Spindles have to be tilted to different cutting angles any drive other than direct is most cumbersome. Even where the Cutter Spindle does not have to be tilted, it has been found advantageous to use built in motors. The latest "White" 12″ x 5″ fully motorised



12″×5″ Fully Motorised Planing and Moulding Machine Type 555M.

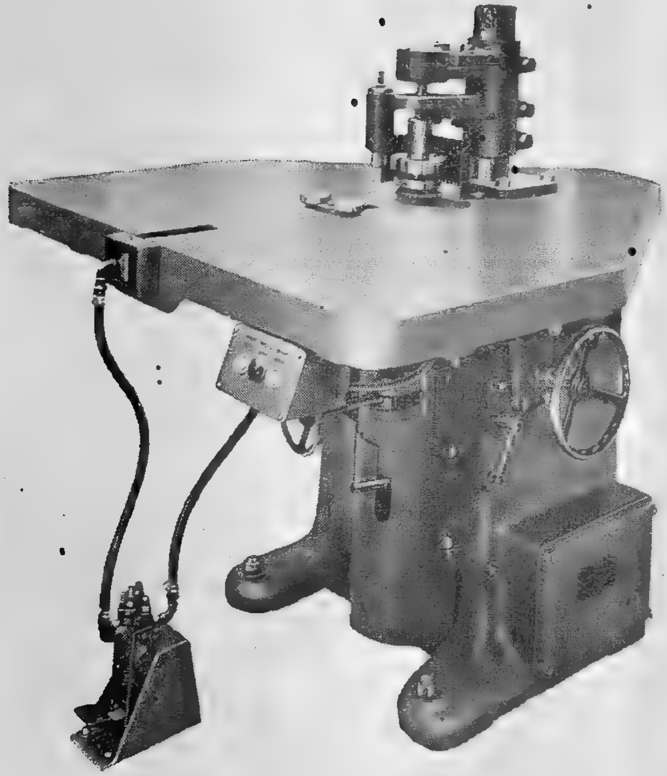
Planing and Moulding Machine, Type 555M is illustrated. On this machine all the Cutterhead Motors are built-in, a separate Motor being used for driving the feed gear and another Motor for quick raising of the Feed Rolls in case of emergency. Built-in two pole Motors rotate at a synchronous speed of 3,000 r.p.m on a 50 cycle electrical supply and as this speed of rotation is too slow to guarantee good quality finish on the planed timber at high feed speeds, it is necessary to raise the cutter spindle speeds by using a Frequency Changer. Stepping up the frequency from 50 cycles per second to 75 cycles per second gives a Cutter speed of approximately 4500 r.p.m., which is adequate for most purposes. Although a Frequency Changer is a fairly expensive item of equipment, this cost spread over 20 years is negligible compared with the initial cost of laying down a countershaft or long belt drives and the annual replacement cost of the belts themselves.



12″×4″ Planing and Moulding Machine Type 444.

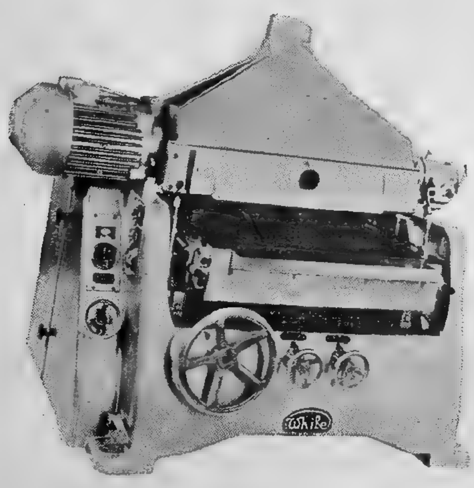
The other popular method of drive is by means of individual motors mounted on the machine and driving the Cutter Spindles by means of short flat nylon plastic belts. An example of this type of machine is to be found in the 'White' 12″×4″ model "444" Planing and Moulding Machine (see illustration). This machine has certain novel features. On the conventional type of Planing and Moulding Machine the Table, over which the work passes, is immovable and the Cutterheads are adjusted relative to this fixed Table. On the model "444", however, the Top Feed Rollers, the Top Cutterhead and Top Pressure are all fixed and the Table which carries with it the Bottom Feed Rolls, the Bottom Cutterhead and the two Vertical Heads is adjustable up and down. All the Cutter Spindles are driven by high speed endless belts from motors forming an integral part of the machine. A Multiple Plate Clutch in the feed drive ensures smooth starting and instant stopping of the feed. The feed speeds are infinitely variable between 30 and 80 feet per minute and the actual feed speed is indicated on a Tachometer. In this case the variable feed speeds are obtained by means of Hainsworth type expanding pulley belt drive. With this type of drive the speed range is normally restricted to a maximum of 3 to 1.

An interesting development in shaping is to be found in the "White" Automatic Spindle Shaper, Type M. P. As will be seen from the illustration this is basically the same as a conventional Spindle Moulder. Mounted concentrically with the Cutter Spindle, but independently driven is a sprocket and Guide Collar. The component, to be machined on the edge, which may be a Table Top, a Chair Seat, a Window Frame, a Kitchen

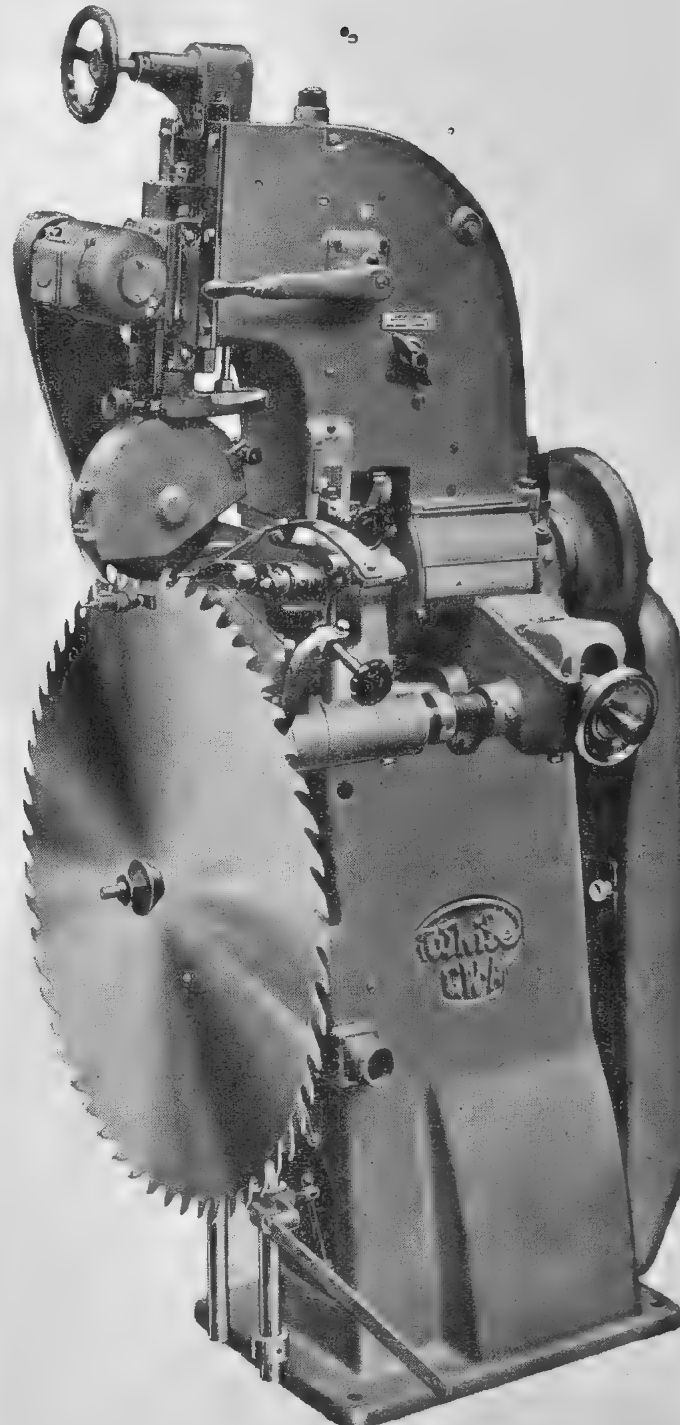


Automatic Spindle Shaper Type MP.

Cabinet Door or similar shaped component, is placed on a Jig around the outside of which is fixed a chain. A pneumatic Ram holds the template of the Jig in contact with the Guide Collar and at the same time brings the chain into mesh with the sprocket. As the sprocket rotates it causes the Jig carrying the component to be moved past the rotating Cutters, thus automatically shaping the edge of the component without any effort on the part of the operator. Maximum output is achieved by using two of these Automatic Spindle Shapers



Double Drum Sander Type BDB.



Automatic Saw Sharpener, Type GWA.

controlled by one operator, the operator loading one machine while the other is cutting.

Drum Sanding is still the fastest and most satisfactory method of finishing wood components. The output from a Drum Sander is very much greater than from a Belt Sander, because of the continuous feeding

arrangement. An illustration of the new "White" Double Drum Sander, Type BDB is shown. The abrasive coated paper is wound onto the drums in the form of a spiral and is kept taught by a special tensioning device. Each drum is driven by its own built-in motor and the drums oscillate axially while rotating.

The conveyor bed is mounted on knife edges and the platens against which the work is held are specially ground to ensure extreme accuracy. The feeding speeds are infinitely variable between 14 and 35 ft. per minute, the actual feed speeds again being clearly indicated on a prominently placed Tachometer. The Exhaust Hood is hinged to enable it to be swung clear when access is required for changing the abrasive paper.

Apart from the Production Shops the designers have also given attention to the Toolroom and Machines are now available for sharpening all types of Saws and Cutters automatically. For example the "White" Automatic Saw Sharpener, Type G. W. A. illustrated will sharpen Circular Saws up to 60″ dia., Bandsaws up to 10″ width and, of course, will also sharpen Frame Saws. By adjusting cams built into the machine any normal tooth shape can be reproduced. The sharpening is done by means of a Grinding Wheel and the Head carrying the Wheel moves up and down on machined slides and also swivels to the left and to the right to give the correct alternate bevels on the Saw Teeth. This type of machine guarantees the proper spacing and shape of the teeth which is so important for accurate and efficient cutting.

In this article it has only been possible to touch lightly on some of the more important recent developments in the design of Woodworking Machinery. There have, however, been many other developments which, although not spectacular in themselves, have nevertheless represented another step forward on the road to progress. It is difficult to forecast future developments, but as we are on the threshold of the age of Atomic Energy and Automation, it is only to be expected that the next decade will produce some revolutionary changes in the Woodworking Industry.

RECENT DEVELOPMENT OF GANZ RAILWAY DIESEL ENGINES

BACKWARD GLANCE TO THE LAST DECADES

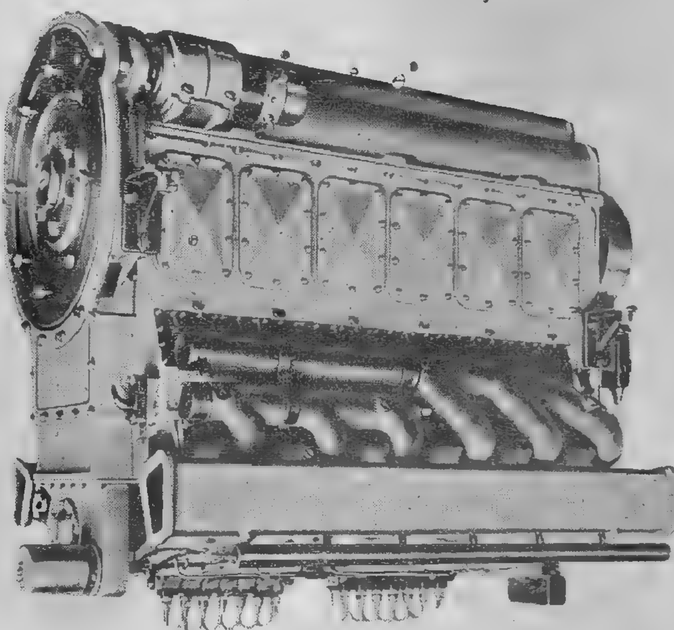
IN the twenties of present century a considerable impetus has been given to the Hungarian diesel engine construction by developing at the Ganz Wagon & Machine Works, Budapest an original type of diesel engines. Around 1925 have been started the first experiments with solid-injection diesels. The trials led by Mr. G. Jendrassik a mechanical engineer of the Ganz Co., have soon led to success. Up to 1929 about 100 diesel engines have been built and many of them have been incorporated into railway vehicles. After 1929 the existing models have been substantially redesigned and a number of new types has been developed. In the following years engines of 135, 240, and 320 b. h. p. respectively have been constructed, chiefly for railcar operation. All the models have been modernised at 1939 and the new types / rated one at 450 b. h. p. and the other at 600 b. h. p. / were added. During the last war, in the years 1944–45, the Ganz factory could not be saved from war devastations, most of the shops and other buildings were left in ruins. After the war first and most important was to rebuild the factory.

From the second world war to the last year generally speaking the prewar types have been built by Ganz, while of course minor improvement have been constantly applied but they were not of a nature touching the general design of the diesel engines. Most important was the introduction of pressure charging. Trials to this effect have been conducted before the world war but without coming to a definite close.

MAIN FEATURES OF GANZ DIESEL ENGINES

The wide popularity of Ganz diesel engines may be attributed to a number of excellent properties. Characteristical features of Ganz engines are:

Fuel injection system, which is perhaps the most important individual feature of these diesels. The working principles underlying to its design are as follows: fuel injection is effected during the whole stroke of the injection pump plunger. The stroke may be regulated from zero to a maximum length and simultaneously the dosing of fuel is undergoing a corresponding. The injection plunger is during the fuel-admission-stroke, pulled back by a cam and



simultaneously a strong helical spring located under the plunger is compressed. At the start of injection retaining effect of the cam is terminated and injection starts in a sudden shocklike manner under action of above mentioned compressed helical spring. After injection is finished, at the end of the stroke of the plunger, motion of the plunger is stopped by the insert between spring and plunger being caught by hitting the fuel pump casing. Thus the stroke is terminated in a very positive and sharply accentuated manner. The method of fuel injection possesses a few very important advantages, namely:

1. Injection is started by the impact of a compressed spring. The pressure above the injection plunger is dependent only and alone on the elastic force of the helical spring. Consequently there is no need for a closed atomizer, for a spring-loaded needle-value as uniformity of the injection pressure is ascertained by the elastic force of the helical spring, from the beginning of the injection stroke to its end.

2. Perfect atomizing is made sure independently from engine speed. In this way good atomizing is assured even at a very low speed, namely when starting the engine. This fact is leading to very easy starting of the Ganz engine.

3. The Ganz fuel injection pump has the advantage of allowing an extremely simple design of the atomizer. The atomizer is simply a conical blow-pipe. For preventing combustion-gas entering into the atomizer, a check valve provided with a soft spring is applied. Atomizers of this simple design are very long lived.

4. The movement of fluid oil under high-pressure is not controlled by the injection plunger or its admission and delivery valves, with other words: there are no control edges which could be worn out by erosion caused by movement of fuel oil containing impurities. Maximum stroke of the injection plunger is comparatively very small, in smaller engines it is about one mm., in the biggest diesels not more than four mm. Consequently the life of an injection plunger is very long, even after repeated general repairs, there is no need for exchange of the plunger.

5. Maximum stroke of a Ganz-type fuel injection plunger may be adjusted with a micrometer gauge and in this way the quantity of the injected fuel is precisely determined. The spring-force required can be adjusted by using a spring scale or a pressure gauge and no other measuring instruments are for this purpose required.

The stroke of the injection plunger may be varied by shifting the centre of rotation of the lever which serves for compressing the helical spring. When shifting the rotational centre of the lever, the stroke of the injection plunger will change accordingly. The moving wedge is shifted by the elastically coupled draw-bar in unloaded state of the wedges i. e. after the injection has been finished and compressing the helical spring has not yet started. Thus the power required for regulation is small and the wedges may be shifted easily, either manually or from the governor.

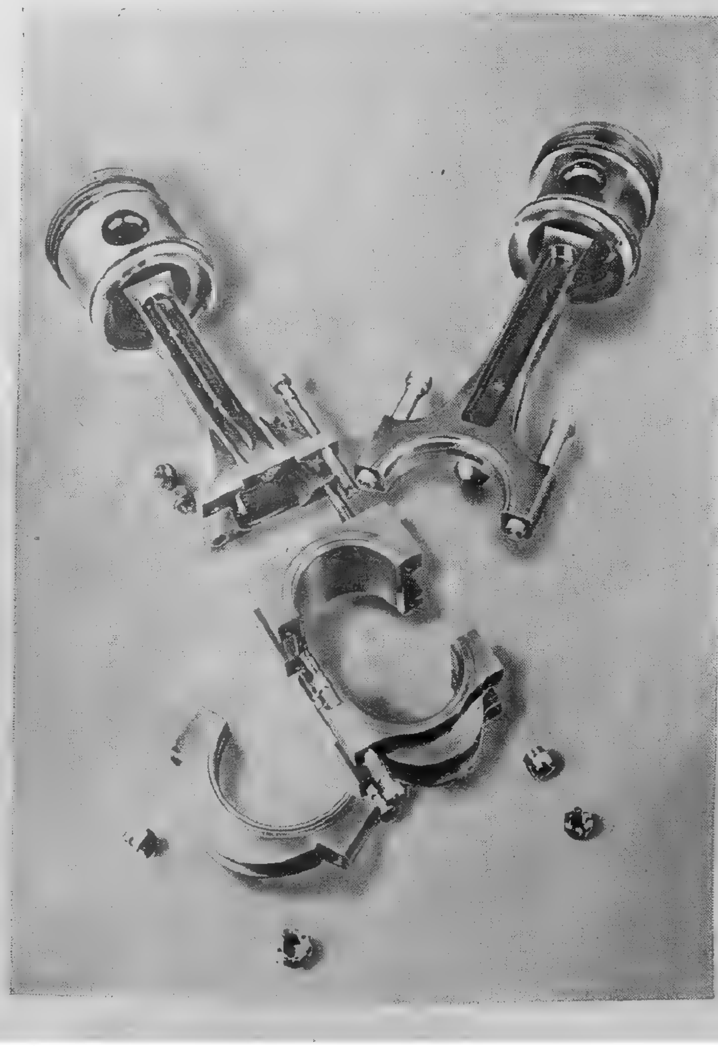
COMBUSTION SPACE

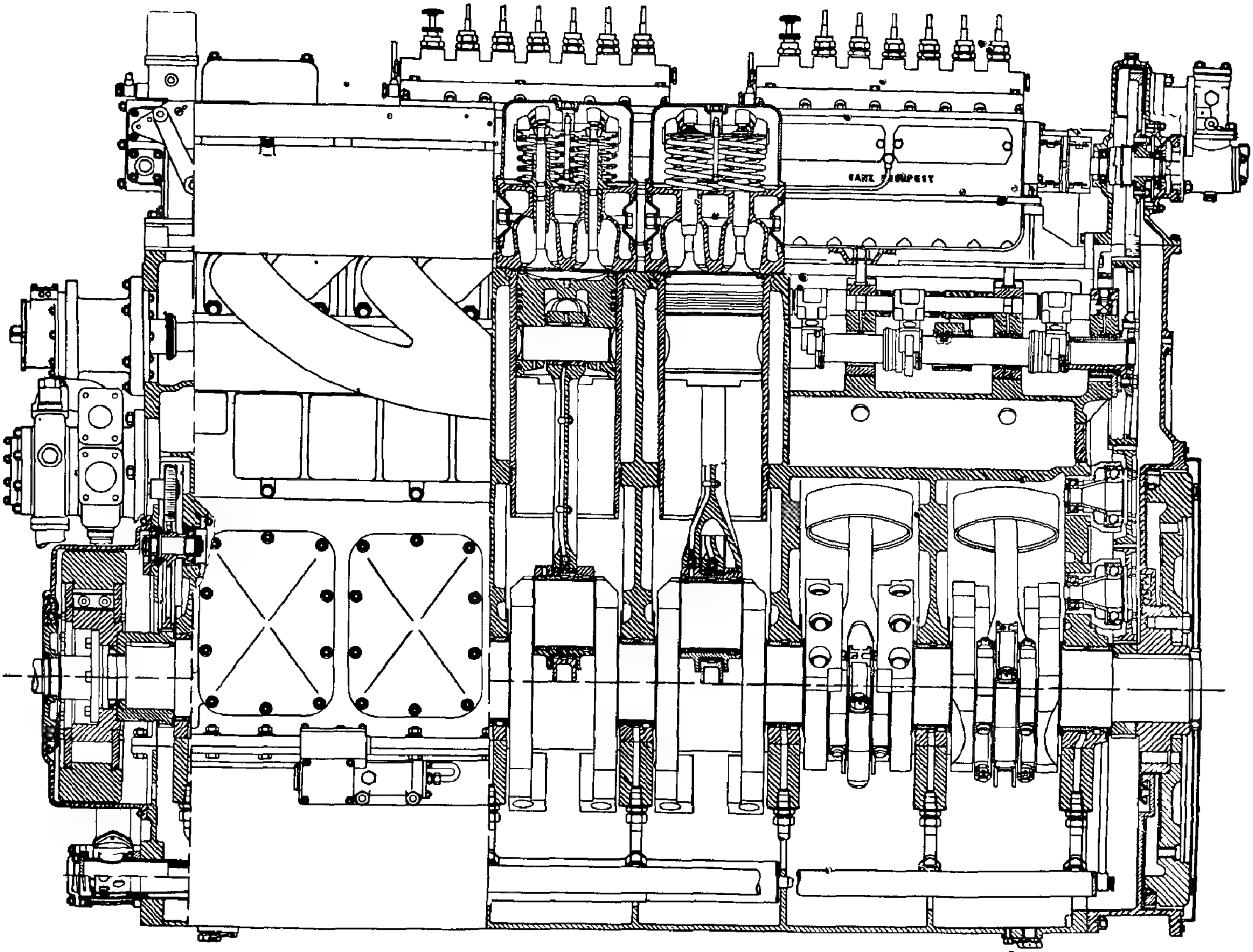
The Ganz engines are fitted with an antischamber if cylindrical shape with comparatively big openings. The fuel oil jet injected through the one-bore atomizer passes along the axis of the cylindrical antischamber and in atomized state rapidly evaporates and ignition is started. The fuel-jet, after such preparation, leaves the antischamber through the large-diameter openings in the bottom of the antischamber and it gets mixed with the compressed air in the cylinder space. It may be seen from above said that the antischamber is a transition between precombustion-chamber and direct injection.

Characteristical for the combustion space of Ganz engines is that, aided by a suitable injection-system, good efficiency and easy starting are attained in spite of the comparatively low compression rate of 1 : 13.

STARTING

An individual feature of Ganz diesel engines is the fact that they can be easily started even in severe cold. Principle of the starting system is as follows: The design of the camshaft controlling the movement of the valves is such that it can be axially shifted until in its starting position the motion of the air inlet valve is controlled by another cam. This starting air inlet cam is designed to open the air inlet valve towards the end of the inlet stroke. Until the inlet opens a certain degree of vacuum is generated in cylinder. After the air inlet valve being opened,





the air streaming with high velocity into the cylinder will raise the temperature of the cylinder as the kinetic energy of the air will be transformed into heat. At the end of the air-inlet stroke the temperature of the air admitted into the cylinder will be consequently considerably higher than it was before entering the inlet pipe. As we mentioned before, the engine is a tipically easily starting diesel but, with the starting device described above starts at an ambient temperature of 20°C below freezing point, can be performed with ease.

MODERNIZATION OF GANZ DIESEL ENGINES

What were the reasons for modernization?

In 1953 management of the Ganz Wagon and Machine Works decided to redesign and standardize the different types of diesel engines. The reasons for this decision have been manifold. Further improvements on the existing types would be difficult. The general layout of the old types does not admit substantial weight reduction. There are also great difficulties in the way of increasing the output of the old models. In course of long years of operation it turned out that assembly work and maintenance of the engines should be made simpler. The number of common component parts of engines with the same bore and stroke but of different number of cylinders should be as high as possible and in any case higher than up to now.

The engine designing office came to the conclusion that all above requirements can be satisfied if the Ganz engines are going to be entirely newly designed. It is self-evident that the well-proved fuel injection-system, combustion-space layout and starting device will be retained in basically unchanged but in some details modernized form.

THE NEW TYPES

The new types should cover a range of from 7 b. h. p. to 2000 b. h. p. rating including diesel engines, for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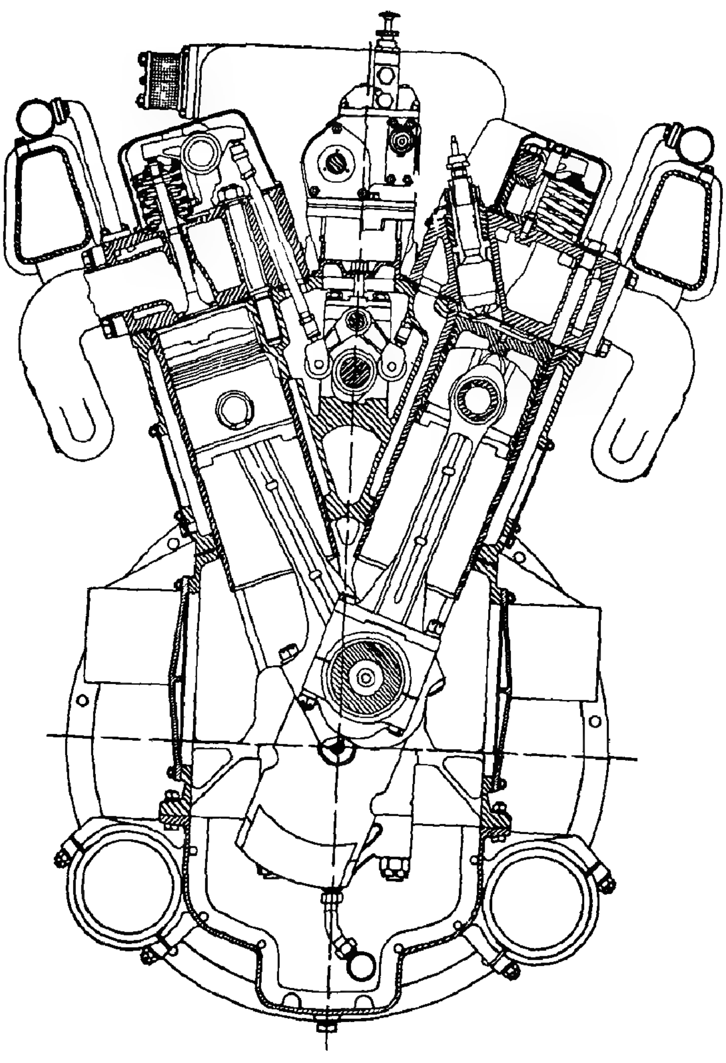
railway traction, stationary and ships, engines. The new types of railway diesels are as follows:

27 cm. cylinder bore engines executed at six or twelve-cylinder units with ratings of 1000 and 2000 b. h. p. respectively at 850 r. p. m. Both engines are pressure charged.

17 cm. cylinder bore—engines. The 6-cylinder model is rated at 250 b. h. p., at 1250 r. p. m., naturally aspirated, while pressure charged the rating increases to 400 b. h. p.. The twelve-cylinder model of the same group is rated at 500 b. h. p. when n. a. or at 800 b. h. p. when p. ch.

Of the 13.5 cm. bore engines the six-cylinder type is a one-bank horizontal engine, with a rating of 150 b. h. p. at 1650 r. p. m. When naturally aspirated or 200 b. h. p. if pressure charged. The twelve-cylinder two-bank horizontally arranged engine is rated at 300 b. h. p. at its n. a. version and at 400 b. h. p. at the p. ch. execution. This group is intended for railcars, but a six-cylinder engine with one bank of vertically arranged cylinders is provided too for smaller locomotives and railcars.



FEATURES OF THE NEW TYPES

Although the ouputs of the new type engines as enumerated above vary between wide limits, their design is based on a uniform base.

A common feature of all models is that the cylinder banks are one-piece castings with exchangeable cylinder liners which are of the wet liner type being in contact with the cooling water. Each cylinder is provided with its own individual cylinder head. The antischambers are designed with inclined centre-line and they can be dismounted while the cylinder head is left in its place. Each cylinder head contains one air inlet and one exhaust valve. With the one-bank engines the camshaft is located on the lower part of the cylinder block. The two banks of the V-engines are provided with one common shaft mounted between the two-cylinder blocks and actuating the valves of both banks; this common camshaft is in the longitudinal centre-plane of the engine. As we mentioned above, the camshaft can be axially shifted and three positions of same exist: working-starting and decompression-position. The camshaft is longitudinally shifted by a manually actuated device; the handlever can be dismounted if the lever is in a working position. The valve-actuating push rods may be fitted with a valve-clearance equalizing device.

In the 17 cm. and 27 cm.-bore engines the connecting rods with the pistons can be dismounted through windows located in the side walls of the crank-case. The connecting rods of the V-engines are of the fork-and blade-type. In course of dismounting the connecting rods and the pistons through the openings in the crankcase wall no part of the engine needs to be dismantling the lids of the windows. Thus bearing bushes and piston rings may be inspected and exchanged without major mounting work being necessary. Pistons and connecting rods of the 13.5 cm. bore engines can be extracted and removed identically.

The crankshafts of the one-bank vertical engines with 17 cm. cylinder bore and of all types of the 27 cm. bore diesels are supported in bearings located in the crankcase. Division of the crankcase is in the bottom-plane of the cylinder-block; the crank case is of U-section. This layout is resulting in a very rigid and yet light construction. The cylinder block and crankcase are connected with long bolts and this construction allows the force being transmitted on the shortest possible way

from the main bearings of the crankshaft to the cylinder heads. A similar layout was adopted for the vertical-cylinder bank model of the 13.5 cm. bore engines.

An interesting feature of the group with 13.5 cm. cylinder-bore is that the 12-cylinder model with two banks of horizontal cylinders is derived from the 6-cylinder horizontal engine by mounting to its crankcase the cylinder block of the vertical 6-cylinder model.

AUXILIARY EQUIPMENT TO THE NEW TYPES

Cooling water pump, lubricating oil pump and the camshaft shifting device are located on the front end of the engines. Fuel injection pump and governor are mounted on one side of the vertical one-bank engines, while the same machines are put between the shanks of the V-engines, in the simmetry plane. Each of the auxiliary machines can be dismounted without touching other parts of the engine.

FUEL INJECTION PUMP

As we mentioned above, the system Ganz-Jendrassik fuel injection pump has proved to be a very successful construction, its basic idea being fuel injection effected by the elastic force of a compressed helical spring. In the new types of diesel engines two important modifications have been effected.

First of all the pump has been redesigned to be suitable for fuel injection in two stages, after exchange of a few component parts. Aim of the two-stage injection is to stop the characteristically sharp, knocking sound of diesel combustion and pressure, a feature having very favourable effect on the life of piston rings and bearings.

The second alteration was that a safety quick-cut out device is built in into every fuel oil pump. The aim of this device is to automatically prevent increase of engine speed above the admitted speed limit.

GOVERNOR

The engine speed regulating device of governor is with all new types of Ganz engines mounted on the exterior of the diesel engine. According to the operational requirements, the functional performance expected from the governor of a diesel engine may be very different. The governors of railway traction diesel engines are hydraulic servoregulators as this type of control mechanism can be adapted in the most satisfactory manner to the complex requirements araising in railway power vehicles. The governor incorporates the remote control systems too, which is of the electro-pneumatic type.

An automatic device is incorporated into the governor with the aim of stopping the engine in the case that lubricating oil pressure should drop below a predetermined limit.

LUBRICATION

All engines belonging to the 17 cm. and 27 cm.-bore groups have the "dry crankcase type" lubricating system. A lubricating oil reservoir is located close to the engine and from this tank is sucked the oil by the oil pump and driven through the filter into the lubricating oil ducts of the engine. Another oil pump is permanently removing the oil from the crankcase. This clearing oil presses the oil through a filter into the oil cooler and from there to the oil tank. Thus the lubricating oil system consists of a high-pressure circuit and low-pressure circuit. The oil cooler is put into the low-pressure circuit which arrangement enables the use of air-cooled radiators for oil cooling.

The 13.5 cm.-bore engine possess similarly two oil circuits of higher and lower pressure respectively. But there is no separate oil tank in these engines, the crankcase serving as oil tank.

COOLING WATER CIRCULATION

Water circulation is effected in all new engines by a single centrifugal pump. The water pump is of a special design without buffing boxes which latter circumstance means considerable simplification of maintenance work.

CLOSING REMARKS

Although there are many types of Ganz engines not intended for railway operation yet in the production programme of Ganz Wagon and Machine Works the railway diesel engines are the most important sector. This can be explained by the fact that railcar building is the traditional domain of Ganz's activity and that this factory has been and is presently too in the rows of the pioneers of the constructors of railway rolling stock and machinery. Above described types of railway diesel engines are able to satisfy all requirements of railcar building but in each category can be found engines to be used as locomotive diesels.

There is also a complete range of stationary diesel engines from 7 to 1600 b.h.p. rating. The same engines are used in river and seagoing motorboats.

Manufacture of Electrical Switchgear and Motor Control Gear

By Our Engineering Correspondent

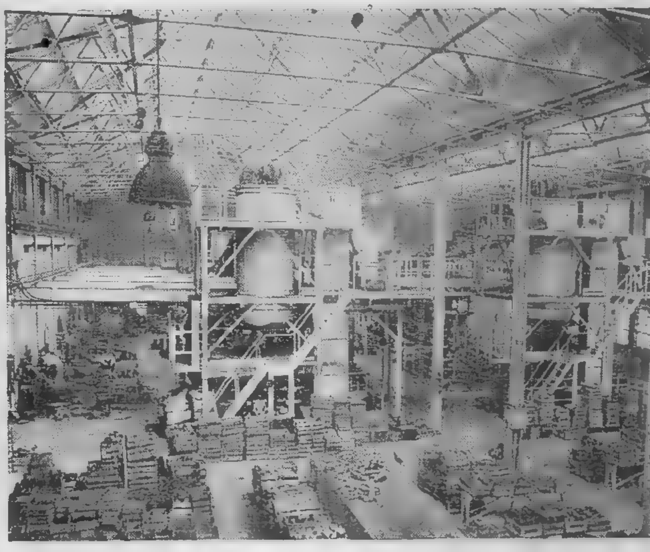
FOR nearly 50 years, the Midland Electric Manufacturing Co., Ltd., has specialised in the manufacture of electrical switchgear and motor control gear and to-day it is one of the most highly organised and most frequently visited factories in the Midlands. Founded in Conybere Street, Birmingham, in 1908, the steady expansion of M. E. M. has led to various moves, first in 1910 to Rea Street South, then to Barford Street. The present 14 acre site was purchased in 1936 and extensions were completed in 1939 and 1953.

Last year, an additional factory site was acquired at Redditch; building is well in progress and the works will be equipped with the most modern plant. It is planned that this factory will be devoted entirely to the production of domestic heating appliances and thus relieve pressure on working space at the Tyseley Works, where switchgear and motor control gear is scheduled for further development.

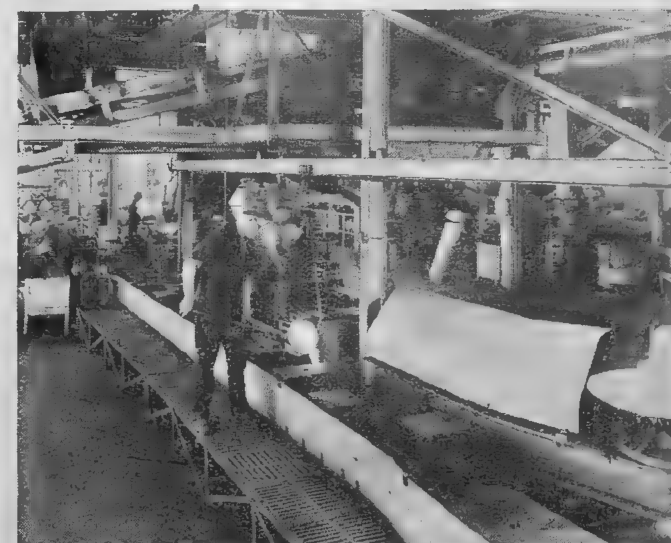
South Works and Administration Block.

The idea of a self-contained organisation has been apparent from the beginning and can be traced back through the years, the introduction of an iron foundry and porcelain works in 1924 and 1925 being major steps in this direction.

The installation of a metal extrusion mill in 1953 brought further economies in the manufacture of non-ferrous components, including contacts and terminal



A general view of the M. E. M. Foundry
Two fully mechanised moulding plants are in use—in the foreground of the picture are shown the sand preparation units where the sand is conditioned for moulding and passed out to the batteries of moulding machines by conveyor.



After the moulds are made, they are brought by conveyor to the pourer. Molten metal is taken from the Cupola by ladles which run on an overhead mono-rail to reduce fatigue and lessen the risk of accidents. The cupolas are designed to give a continuous flow of metal throughout the day.

blocks. New methods of producing basic parts of M. E. M. products are constantly being sought and, to-day, castings, porcelain and plastic mouldings are manufactured in vast quantities by special purpose machines, within the Tyseley Works.

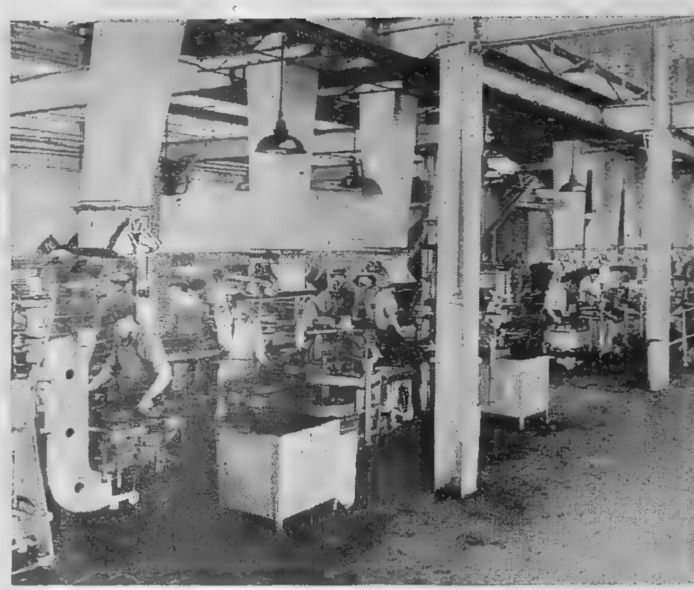
The manufacture of nearly 1,000 catalogue items demands a high degree of internal organisation and closer examination of two of the more interesting works departments gives some idea of the productive capacity which has been built up over the years.

M. E. M. is unique in having its own porcelain works. The clays and basic materials are obtained from Devon and Cornwall, and some are imported from Sweden. All the press tools for the moulds are made in the M. E. M. Toolroom and the clay 'body' is moulded into shape by hydraulic presses. After pressing and preliminary drying the 'flash' is removed and the pressings are glazed and cleaned ready for firing. Girls working on either side of a conveyor carry out the fettling and cleaning and each working place is provided with air extraction to remove dust from the atmosphere. Glaze is sprayed on automatically before the final cleaning and inspection operation. The pressings are finally loaded on to trucks and moved slowly through the 130 ft. kilns, the complete journey taking 40 hours. Town gas is used to obtain the temperature of 1250°C needed for firing and the daily consumption is in the region of 70,000 cubic feet. Well over a million pieces of porcelain are fired in the continuous tunnel kilns which are in operation 24 hours a day, 7 days a week.

The M. E. M. pottery works relies entirely upon local labour and the highly skilled operatives are all trained within the department.

When the present factory site was first occupied in 1937, a new foundry was built and in order to produce 60 to 80 tons of light electrical castings per week, it was necessary for this to be a highly mechanised production unit. The average weight of the castings produced is 2 lbs. and a variety of moulding machines are in use, some working in pairs producing the upper and lower halves of the moulds, and others capable of producing complete moulds.

Sand is brought to the hopper of all machines by overhead conveyor. The rate of production is one mould per minute, per man. After the moulds are made they are brought by plate conveyor to the pourer. Molten metal is taken by the "syphon brick" method



One of the moulding plants in the M.E.M. mechanised Foundry. The machines in the foreground work in pairs, producing the upper and lower half of the moulds respectively. Sand is brought to the hopper above the operator by overhead conveyor and by means of the lever at the side of the hopper he can withdraw just the amount of sand required for a mould.

Further along the line are seen machines each capable of producing a complete mould. The average time taken for production of a complete mould on these machines is under one minute.

The "Knockout Station". The conveyor plate carrying boxless moulds tilts automatically. The mould breaks up and the casting with the sand is carried away by another conveyor. The casting is removed for cleaning and fettling and the sand is then reconditioned and fed to the overhead hoppers for use again.

Altogether, some 80,000 castings are made in the M.E.M. Foundry each week.

After pressing and a preliminary drying, 'flash' must be removed, glaze applied and the pressings cleaned, ready for firing. Girls working on each side of a conveyor carry out the fettling and cleaning work. Each working place is provided with air extraction to remove dust from the atmosphere. Glaze is sprayed on automatically, before the final cleaning and inspection operation. In the background is the bay in which trucks are loaded for the kiln. Over a million pieces are fired each month in the continuous tunnel kilns which are in operation 24 hours a day, 7 days a week.

of tapping from the cupolas, which are of the "balanced blast" type. The ladles run on an overhead mono-rail to reduce fatigue and lesson the rish of accidents.

At the "Knockout Station" the conveyor plate carrying the boxless moulds tilts automatically, tipping the mould onto an "apron-plate" conveyor thus enabling the casting to be lifted clear of the sand. The casting is then sent for cleaning and fettling, the sand being re-conditioned and fed to the overhead conveyor for use again.

Cleaning, fettling and grinding is carried out in the main factory building, the layout of which provides an excellent example of flow-line production. Some 80,000 castings are supplied weekly to the factory assembly units and a very high standard of finish is maintained.

Every facility is provided for the maintenance of good working conditions and the M. E. M. Foundry is without doubt, one of the cleanest in the Midlands.

The principles of standardisation of products and simplification of design have been thoroughly applied and this highly specialised unit is typical of the many that make up the self-contained organisation of M. E. M.

Narrow-Gauge Locomotives for India

Efficacious twin-engine design for low-speed heavy pulling power conditions up long and steep grades

FOR many years now the 2-ft. 6-in. gauge Kalka-Simla Railway would have been regarded as one of the most difficult in the world to work if its traffic had been at all heavy. Fortunately, it was mostly Government traffic uphill to Simla and returning traffic downwards at the end of the season. Yet Kitson-Meyer articulated steam locomotives were needed for the heaviest freight and other trains, though 25 or more years ago petrol railcars were introduced for the first class traffic. These small cars were supplemented about 1933 by an Armstrong-Saurer railcar, and at a later date some of the petrol cars were converted to diesel propulsion.

Almost the whole of the 60 miles length is severely curved and lies along shelves on the hillside, so that a speed restriction to 20 m.p.h. has always been enforced. The grades are continuous, for many miles at 1 in 33, with some stretches even steeper, and the line climbs 5,000 ft. from one end to the other to reach an altitude of 6,840 ft. above sea level. These, with a restricted loading gauge, were some of the requirements which had to be met when the Indian Railway Board began to think of diesel locomotives to replace steam motive power.

There was one advantage that diesels did possess over steam, and that was the practicability of choosing as standard a comparatively small unit and coupling two in multiple unit for the heavier trains. The old Kitson-Meyer locomotives, though reasonably successful as steam locomotives, did not have a high ratio of trailing weight they could pull uphill to the locomotive weight. Under physical conditions such as obtain on this line, it

One of the Jung 28-ton 290-b.h.p. (on site) 2-ft. 6-in. gauge B-B diesel-hydraulic locomotives of the Kalka-Simla section of the Indian State Railways.

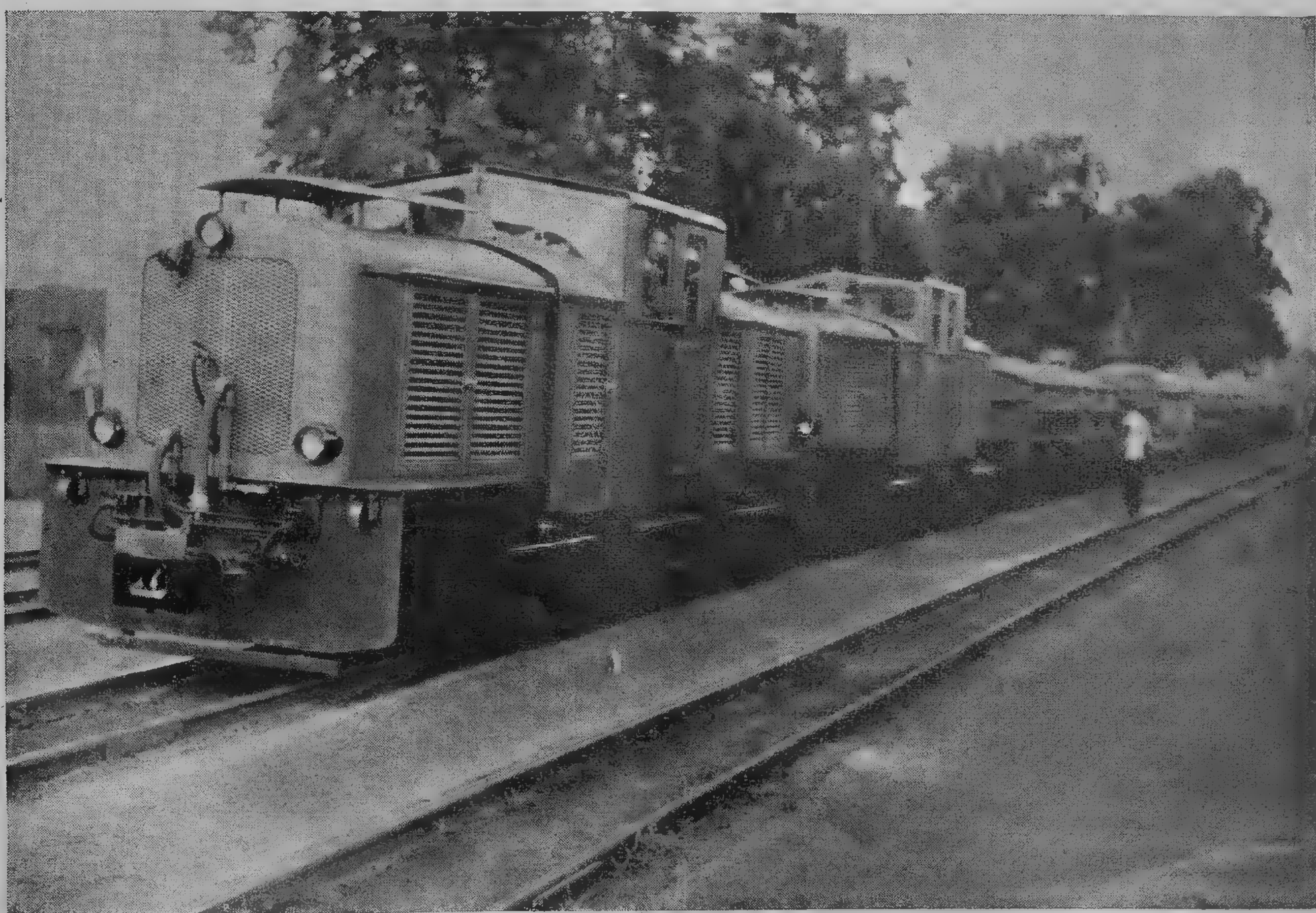
is necessary to make use of every ton of weight for adhesion, and make use of every lb. of adhesion to provide high effective tractive effort, if high operating efficiency is to be gained. Finally, the possibility of getting with diesel traction a smooth-riding bogie locomotive, of short rigid wheelbase, should add to security in situations where a derailment is likely to mean a considerable fall, and should also conduce to less expensive track maintenance compared with steam locomotives of longer rigid wheelbase and the disturbing forces arising from cylinder pressure and reciprocating weights. Fortunately, judged by 2-ft. 6-in. gauge standards, the Kalka-Simla track is good, and an axle load of 7 to 7¼ tons is permitted for diesel locomotives.

THE LOCOMOTIVES CHOSEN

Some time ago the Railway Board placed an order with the Arn. Jung Lokomotivfabrik G.m.b.H. for diesel-hydraulic locomotives to cope with these conditions. The order actually comprised eight locomotives, but only five of these are for the Kalka-Simla line and the other three are for another I.S.R. narrow-gauge line in Western India. The only difference between the two is that the K.S.R. locomotives are fitted with multiple-unit control for the handling of two locomotives by one driver.

To meet the developing ideas of the Board, and in accordance with Jung's ideas to have a design suited to other countries also, a locomotive design was evolved which is standard for all gauges between 600 mm. and 785 mm. (1 ft. 11⅝ in. and 2 ft. 7 in.), the only change for any gauge being the distance one wheel in each wheel-and-axle set is moved along the axle. The engine output, and also the weight, can be varied while maintaining essentially duplicate mechanical portions if the gauges at the bottom end of the scale can take, for such light lines, a heavy axle load.

The specification for the Kalka-Simla locomotives called for the haulage by one locomotive of 30 tons trailing load up a gradient of 1 in 20 at 10 m.p.h., and for the haulage of 100 tons trailing up 1 in 50 at 12 m.p.h. On steep railways such as this braking is a problem commensurate with that of haulage, and on the K.S.R. it is complicated as a locomotive design problem in that vacuum equipment has to be provided for the



Two of the Jung 290-b.h.p. 2-ft. 6-in. gauge diesel-hydraulic locomotives of the Indian State Railways.

train brakes, a provision that in these locomotives caused much effort in getting in the necessary piping and auxiliaries and the multiple-unit connections for the piping. With the straight air brake in operation the braking force on the locomotive is equal to 78 per cent of the braked weight; with combined application of the straight air and automatic vacuum systems the locomotive braking is equal to 69 per cent of the locomotive weight.

EVOLUTION OF THE RUNNING PART

Some of the evolutionary aspects of the B+B locomotive design are interesting. Jung has had some experience in building four-wheel rigid-frame locomotives each with its own cab, and close-coupling two together. The company also built the short metre-gauge B+B locomotives of the German Federal Railway Class V. 29 in which practically all equipment was mounted on the bogies, including the engine casings, which were separate from the single cab. In these Indian locomotives the "bogie" mounting of equipment is retained, but here the vehicles or bogies are close coupled; and the cab structure is carried on three-point mounting with two supports on one bogie and one on the other, and all buffing and drag stresses are taken through the frames without going through the cab.

Running experience with these locomotives shows the simple form of close-coupling to be effective, and round sharp curves the running is smooth up to top speeds of 20—22 m.p.h. and there is not much of the entry-jerk common with many bogie locomotives. The specification called for ability to traverse curves of 48 ft. radius, and this has been achieved in track laid at the works. But on the Rhein-Siegen Eisenbahn, in Germany, where trials were carried out prior to shipment, the curves are more of the order of two or three times that value, though the speed at which they were taken was in excess of 12 m. p. h. and curves of about 200 ft. radius were taken at 20 m.p.h.

Maximum grade on the Hennef-Asbach line of the R.S E. is 1 in 60, and during the tests two of the locomotives coupled in multiple unit hauled 240 tons trailing uphill at a steady 10¼ m.p.h. This means 300 d.b.h.p. and allowing for the two locomotives, and the auxiliary requirements, the efficiency through the transmission must have been of the order of 80 per cent.

The locomotive design, is of twin-engine B+B wheel arrangement, with a wheel dia. of 27½ in., and a bogie wheel-base of 4 ft. 11 in. Owing to the method of construction it can hardly be said that there is a bogie pivot pitch; indeed, it is debatable whether the design is really a bogie one at all within the usually-understood meaning of the term, being formed of two close coupled power units with a single cab pivoted above them, and whose riding qualities are equal to those of a bogie locomotive of similar dimensions. Length over buffers is 30 ft. 4 in., maximum width 7 ft., and over all height 9 ft. 6 in. With three-quarters of the total fuel supplies of 1,000 kg. on board the weight is 28 tons, which means that at 30 per cent adhesion a starting tractive effort of about 19,000 lb. can be exerted at the rail. No alternative gears are embodied after the hydraulic portion of the transmission. At the top service speed of 20 m.p.h., the rail tractive effort available is 3,800 lb.

The bogie frame structures are welded up throughout. The SKF-type roller-bearing axleboxes have individual laminated springs, and manganese-steel liners are fitted to boxes and guides. The wheels are of disc type with separate tyres and there is one brake block per wheel. ABC centre couplers are carried on the outer headstocks, along with the air and vacuum brake and electrical connections. Between the inner headstocks of the two bogies the close-coupling means consists of a rigid centre drawbar, and a spring-buffer set at each side, there being a diagonally-opposite arrangement of a spring buffer with a convex curved face on one headstock and a concave wearing plate on the other. Movement takes place only when curving. Each bogie carries a complete engine-transmission-auxiliary plant, so that the locomotive can be worked and all services maintained with only one engine working. The casing covering this equipment is carried on the bogie, but is separate from the cab structure, fitting inside the cab at the inner ends and with enough play to prevent contact on the sharpest curve.

CAB SUSPENSION

A strong but light welded plate underframe carries the thin-plate cab structure. This structure is three-point supported on the two bogies, but the actual means of doing it was one of the most difficult problems in the design of the mechanical portion, partly because of the considerable movement which had to be allowed for and partly because of the restricted space available as a result of the amount of general equipment which had to be installed within a narrow loading gauge. On the bogie with the two supports, a tubular trunnion arrangement is used in which a circular guide bar moves in and out of a tube to a maximum extent of about 4 in., the whole being mounted on hemispherical bearers with rubber supports on the bogie frame. The sliding and tilt in

and radial movements are absorbed by the deformation of the rubber. The single centre support on the other bogie also uses rubber, and is carried on a bridge piece across the frame. It is just below the shaft between the engine and transmission.

ENGINE EQUIPMENT

The engines are of the Motorenwerke Mannheim (MWM) four stroke pressure-charged type TRHS. 5185. At 650 ft. altitude, 68 deg. F. ambient temperature, and 1,500 r.p.m. speed, the six-cylinder engine has a continuous output of 240 b.h.p. But to suit site conditions and Indian railway operating conditions, the rating in the locomotives is 145 b.h.p. at 1,100 r.p.m., 5,000 ft. altitude and 90 deg. F. air temperature. The locomotive thus is of 290 b.h.p. on site. Cylinders are 5.15 in. bore by 7.1 in stroke. Construction is in cast iron with integral crankcase and cylinder block, and wet liners are inserted. Precombustion chambers are carried in the cylinder heads and aluminium-alloy pistons are used. Injection equipment is of Bosch make. Electric starting is used. A Brown Boveri VTR 160 pressure-charger group is mounted at the end of the engine nearest the cab; but as the two Mann & Hummel air filters are carried on the cab structure a flexible bellows connection is needed between them and the pressure-charger air intake.

The engine has three-point mounting of the rubber-bushed trunnion type. From the back end of the engine, between the elastic coupling and the Voith transmission, belt drives are taken off to one side for the Westinghouse reciprocating air compressor, and to the other side for the Körting rotary exhauster. These machines are carried on brackets bolted to the bogie frames, and carry a neat and simple belt-tensioning device formed of a slotted arm.

From the front end of the engine shaft a belt drive is taken for the radiator fan and for a dynamo. The frontal radiator has elements for the engine water, engine oil and transmission oil, and these are protected by a close-mesh grille. The transmission oil is circulated through its cooling system by the delivery pump in the transmission, whose main business is to keep the transmission working circuit filled. Radiator and associated equipment were furnished by the Kuhlerfabrik Langerer und Reich, of Stuttgart.

Three-point suspension is used also for the Voith L. 33 hydraulic transmission, with unsprung ball-and-socket supports. This transmission has one converter and two fluid couplings. From the reversing gears below it, cardan shafts lead forward and backward to simple bevel drives on the axles. Reversing can be effected only with the locomotive at rest.

ACCELERATING USE OF HINDI ON RAILWAYS

RAILWAY Administrations throughout the country are now taking steps to increase the available facilities for teaching Hindi to their staff. Hindi classes are to be started for the benefit of non-Hindi knowing staff, and for this purpose the Railway Board has supplied a model scheme to the Railways.

The Railways will undertake a census of non-Hindi knowing railway employees, covering all categories of staff, including class IV staff who are required to know rules, read names, numerals, etc.

Communications received at Railway Headquarters or at Divisional, Regional and District levels are proposed, as far as possible, to be answered in Hindi. Hindi signboards, notices, etc. displayed on railway premises and in trains will accord with the standardised terminology.

Among other important steps proposed are the issue of Hindi versions of administrative instructions, booklets, circulars, etc., and the publication of Hindi time-tables simultaneously with the English versions.

TOWARDS TWO CLASSES ON INDIAN RAILWAYS

THE first token step towards the abolition of second class accommodation on the Indian Railways is to be taken on July 1, 1956, when this class of accommodation will be withdrawn from some of the smaller branch lines. The coaches thus saved will be utilised to increase second class accommodation on some of the remaining lines where there is need and where second class accommodation will, for the time being, continue.

On sections where second class accommodation is withdrawn, steps will be taken, wherever necessary, to increase third class accommodation. The token withdrawal of second class accommodation from the smaller branch lines is the beginning of a process towards having only two classes on the Indian Railways in addition to air-conditioned accommodation.

Sulzer 2,300-H.P. Locomotive Engine

The new Sulzer pressure-charged twin-row engine for Diesel-electric locomotives has been very well received by railway companies, and a large number of orders have been placed within a very short time. In the type test carried out under U.I.C. regulations, the engine fulfilled all guarantees.

THE first units of a new type of Sulzer traction Diesel engine have been in service since 1955 in the 060-DA locomotives of the French National Railways illustrated in fig. 1. The order originally placed was for 20 units. Shortly after the first engine had been put in service, five further engines were ordered, to which ten more were added in April 1956. The mechanical part (bogie and superstructure) was manufactured by the *Compagnie des Ateliers et Forges de la Loire.* The *Compagnie de Construction Mecanique Procedes Sulzer* supplied the Diesel engines, and the *Compagnie Electro-Mecanique* the electrical equipment. The first ten engines were manufactured by Sulzer Brothers Ltd. in Winterthur, the others have been or are at present being built by the C. C. M. in their works at St. Denis, France. These 120-ton locomotives of type Co Co are being used on the "Grande Ceinture" in Paris for hauling goods trains of 1,600 to 2,000 tons.

In the meantime British Railways have ordered ten identical engines from Sulzer Bros. (London) Ltd., who are also acting as general contractors for the electrical equipment. The superstructure is being manufactured by British Railways in their own workshops at Derby.

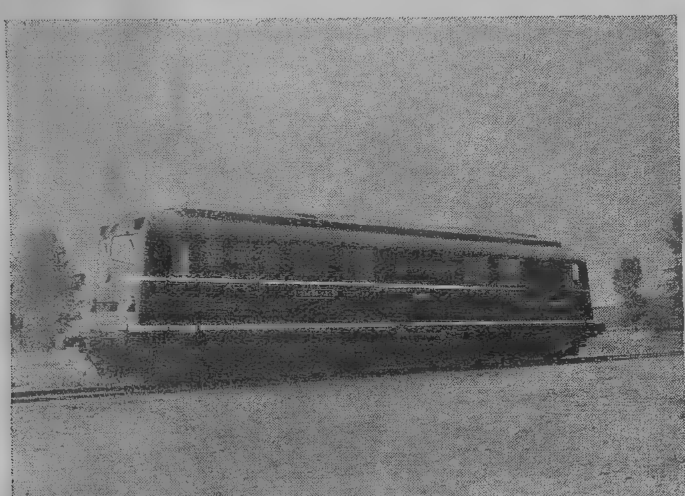


Fig. 1. Diesel-electric locomotive of the French National Railways.

The Sulzer twelve-cylinder four-stroke twin-row engine operates with solid injection and is pressure-charged by an exhaust-gas turbo-blower (see figs. 2 & 4).

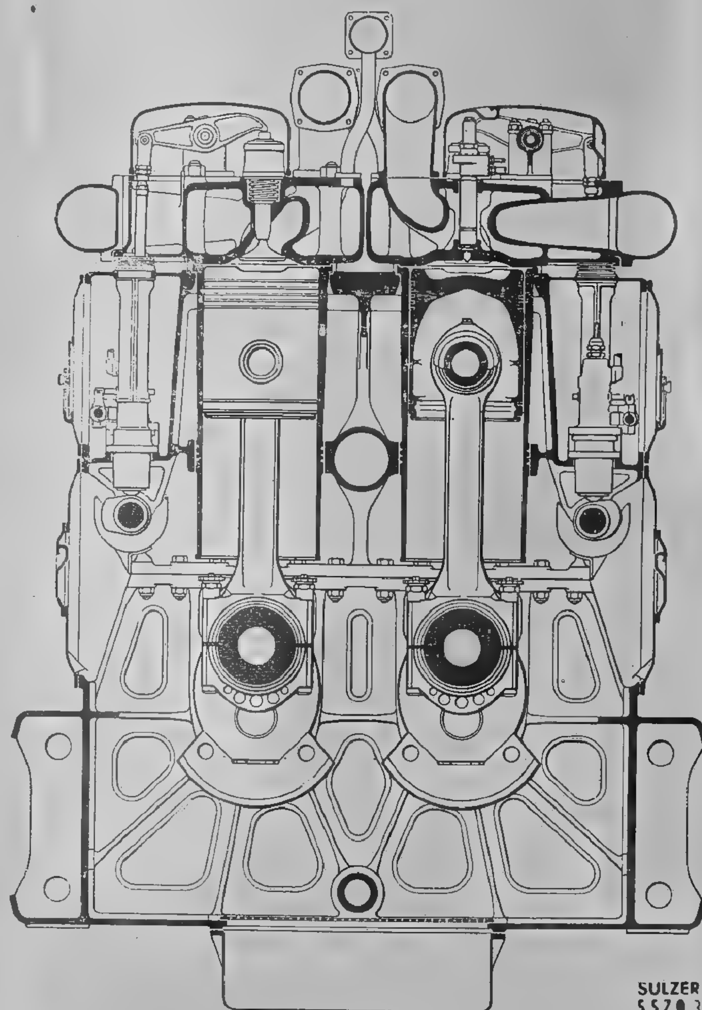


Fig. 2. Section through the Sulzer four-stroke locomotive engine of type 12LDA28.

The Roumanian State Railways have also taken an active interest in these engines and have now placed an order for sixteen of them. The total number so far ordered, including three stand-by sets, has thus reached 64, viz.

French National Railways (including stand-by sets)	38
British Railways	10
Roumanian State Railways	16

One of the first batch of engines for the "Grande Ceinture" was selected at random by the inspection

authority of the French National Railways and submitted to the so-called type test. Under the regulations of the Union Internationale des Chemins de Fer not more than two stoppages of twenty minutes each are allowed in the course of this 100-hour test. In actual fact the engine remained in continuous operation throughout, so that it fully satisfied the requirements.

DESCRIPTION

The twelve-cylinder four-stroke Diesel engine is designed for solid injection and is pressure-charged by a Sulzer exhaust-gas turbo-blower. It has two rows of six cylinders each (fig. 2). Originally intended for 2,000 B.H.P., it has now been brought up to 2,300 B.H.P. by raising the mean effective pressure and the speed.

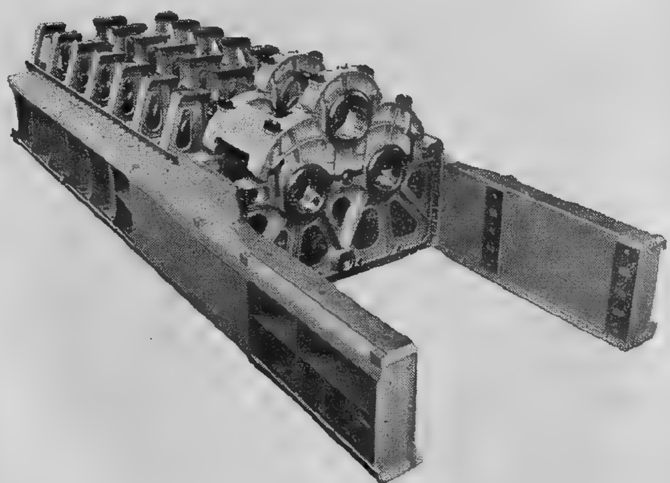


Fig. 3. Welded crankcase.
The longitudinal girders are extended to take the generator. The last two transverse members, with three bearings each, carry the gear.

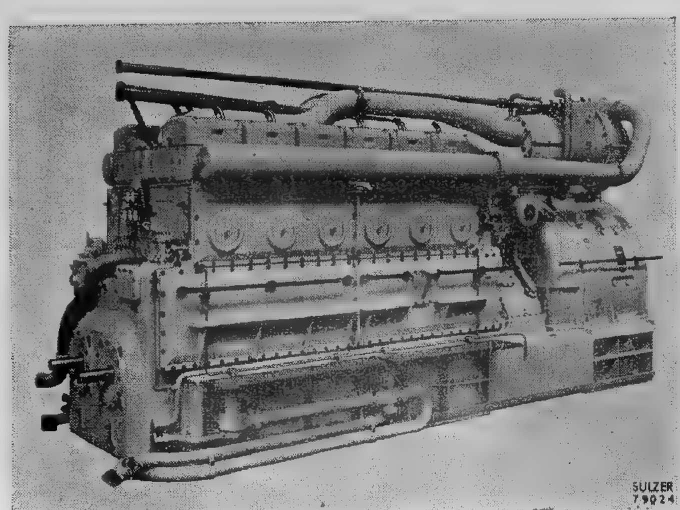


Fig. 4. Engine-generator set.
The compact character of the set is apparent.

The two crankshafts drive the generator through a common gear with a transmission ratio of 1.44 : 1.

The main dimensions of the engine are the following:

Bore	=280 mm. (11 in.)
Stroke	=360 mm. (14.17 in.)
Nominal rating	=2,300 B.H.P. at 750 revs. per min.

The crankcase (fig. 3) is of the welded design which has given such good results in Sulzer Traction engines for the last twenty years. The seven cast-steel transverse members which take the bearings of the two crankshafts are welded to form a rigid whole with the longitudinal girders of steel plate. The latter are extended at one end to carry the generator. The two transverse members nearest the generator support the gear, which synchronises the two crankshafts and steps up the engine speed by 44% for driving the generator.

The Diesel engine thus forms a very compact block with the gear and the generator. U-shaped ribs running

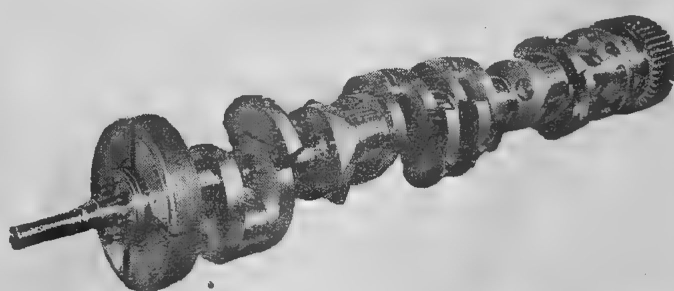


Fig. 5. Crankshaft of the 12LDA28 engine.
On the left, the vibration damper; on the right, the gear-wheel. The counterweights are fitted on the crank webs.

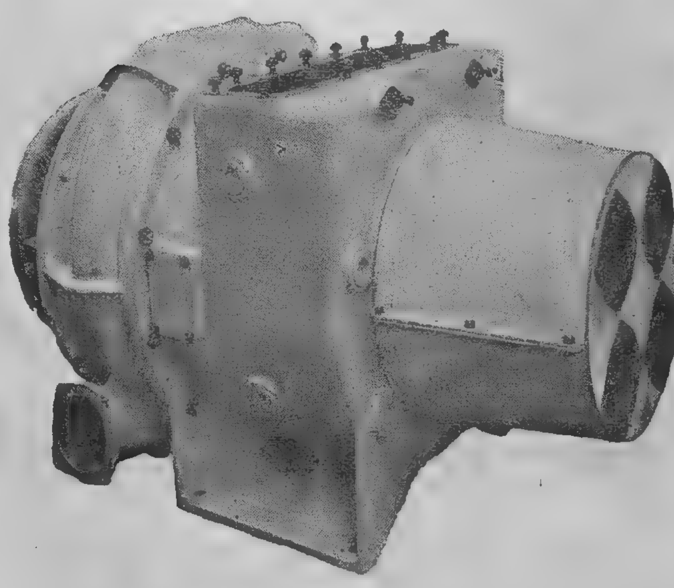


Fig. 6. Sulzer pressure-charging set.

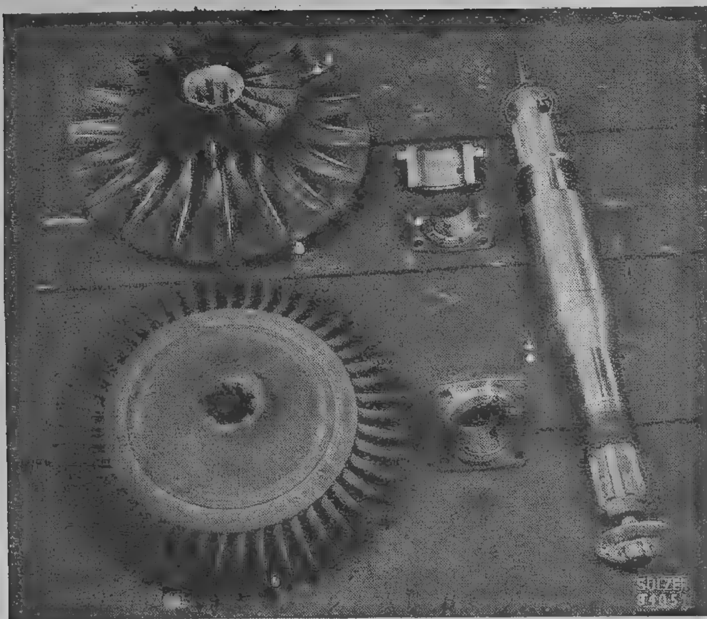


Fig. 7. Components of the exhaust-gas turbo-charger after the test.

Top: Blower impeller.
Bottom: Turbine wheel.
Right: Shaft with bearings.

Fig. 8. Crankshafts after the type test.

round the crankshaft bearings in the transverse members are carried up into the cylinder block which is bolted to the latter, so that the gas forces acting on the cylinder cover are transmitted by the shortest route to the crankshaft bearings, while the other parts of the casing are relieved. This design also permits the crankshafts to be fitted and removed with ease from above.

When the lateral covers visible in fig. 4 are removed, the crankcase is readily accessible, so that the connecting-rod bearings can easily be changed. The main bearings, pistons, cylinder liners and all other parts subject to wear can be replaced speedily and with a minimum of trouble.

The crankshafts (fig. 5) are provided with counterweights which partially balance the masses. Frequencies which might give rise to torsional vibrations are eliminated by the dynamic damper, so that the engine runs very smoothly over the whole range from no-load to well above the nominal speed.

The cylinder block also consists of cast-steel transverse members welded to longitudinal walls of steel plate. The cross-section (fig. 2) shows how the cylinder block is bolted to the crankcase. Removal of the lateral covers gives access to the injection pumps.

The valve push-rods are enclosed in tubes, so that leaking fuel oil cannot mix with the lubricating oil.

The Sulzer exhaust-gas turbo-charger (fig. 6) is fitted on the generator casing. The bearings are lubricated with oil from the forced-circulation system supplying the engine.

A special pressure-charging safety device ensures that the quantity of fuel injected is never more than would correspond to the momentary volume of charging air. This point is particularly important during rapid load increases, as at such times the air delivery is always somewhat in arrears owing to the inertia of the turbo-blower rotor.

Other safety devices stop the engine or slow it down to no-load speed when the pressure in the cooling-water or forced-circulation oil systems falls below a certain minimum or when the water temperature rises too high.

TEST RESULTS

In the type test already mentioned the air was aspirated from the atmosphere and was not cooled between the blower and the engine. For the first eleven hours, the engine ran at slightly above the nominal output of 2,300 H.P. As the outside temperature was only 6–7°C. the output was then raised to 2,360 H.P. so that the thermal loading was roughly the same as at the nominal output and 20°C (the definition of the nominal output in the regulations of the U. I. C. being based on this temperature). The mechanical stressing during the test was thus somewhat higher than at nominal output.

The fuel used had a specific gravity of 0.843 (measured in gr. per cu. cm.) at 20°C. and a net calorific value of 10,090 cal. per kg. (18,015 B.Th.U. per lb.).

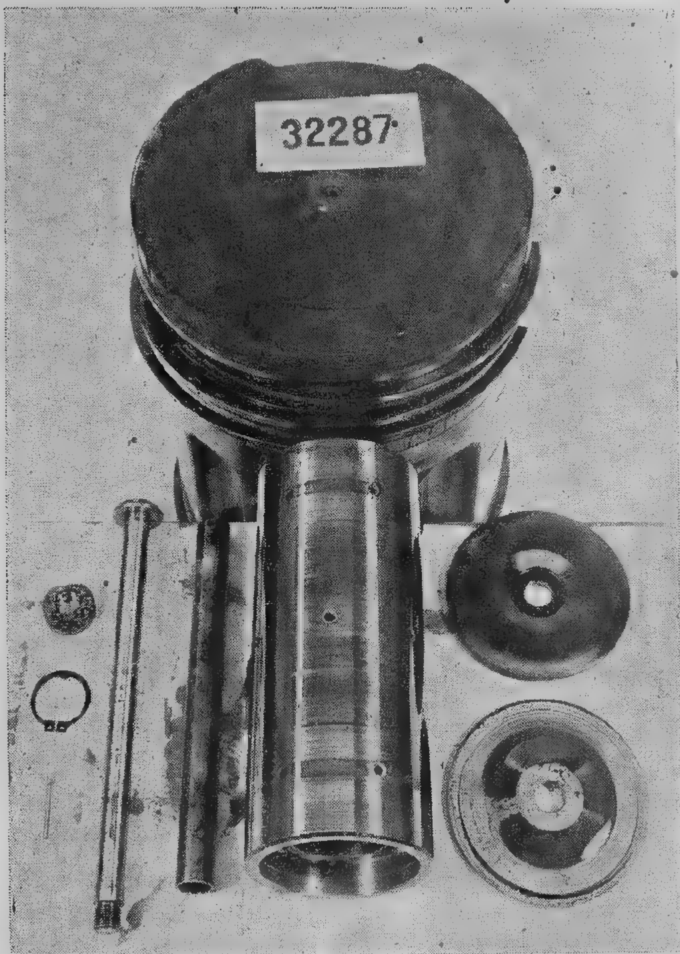


Fig. 9. Parts of the pistons after the test.

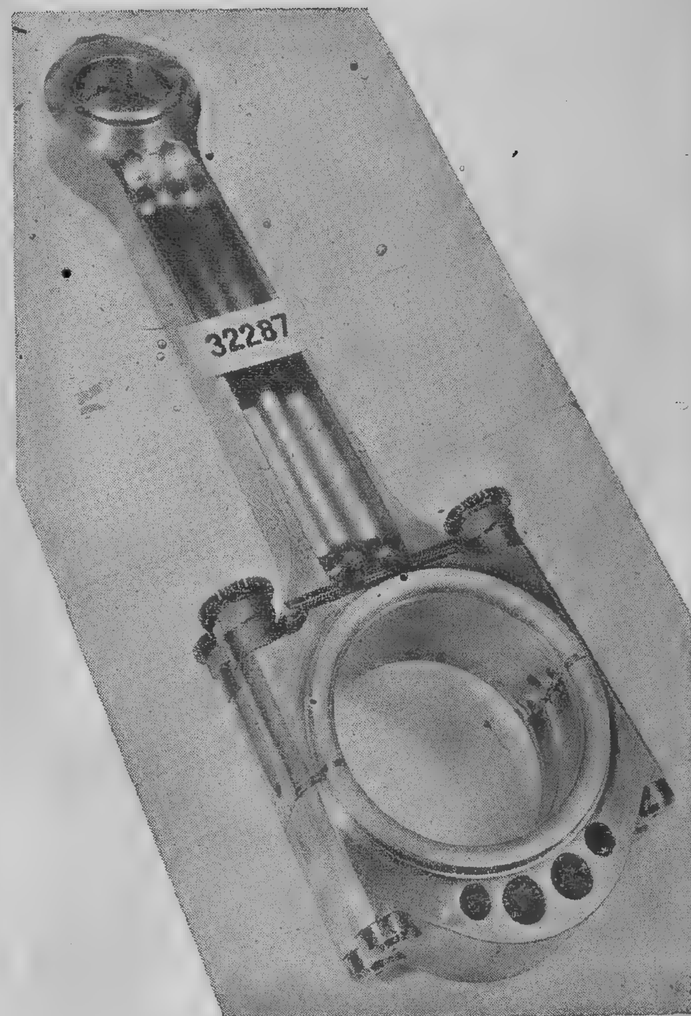


Fig. 10. Connecting-rod after the test.

The results of the test are given in Table 1. The figures are averages of measurements made every hour, or every half-hour in the tests of shorter duration.

Of the total heat supplied during the continuous test at 2,360 H.P., the following percentages were converted into power or led off in gases, coolant and lubricant :

37.2% converted into power
14.9% dissipated by cooling water
5.9% dissipated by lubricating oil
42.0% led off in exhaust gases lost by radiation, etc.
100 %

After the test the engine was completely dismantled for inspection. Figs. 7–10 illustrate the good condition of the various components.

Rel. humidity = 75%
Barometric pressure = 727 mm. Hg.

Type of test	Duration	Output	Speed	M.e.p.	Consumption	Charging air			Exhaust gases				Speed of Turbo Charger
						Temp. at turb. inlet	Pressure at entry to engine	Temp. at entry to engine	Temp. after leaving valve	Pressure at turbine inlet	Temp. at turb. inlet	Temp. at turb. outlet	
	hr.	B.H.P. (metric)	r.p.m.	kg./cm.^{2}	gr./B.H.P.-hr. (metric)	°C	mm./Hg.	°C	°C	mm./Hg.	°C	°C	r.p.m.
Continuous run	11	2314	750	10.65	168.2	6.0	492	67.8	476	250	585	472	10700
at nominal load	69	2360	750	10.88	169.4	7.0	505	70.5	483	263	592	492	10900

Type of test	Duration	Output	Speed	M.e.p.	Consumption	Charging air			Exhaust gases				Speed of Turbo Charger
						Temp. at turb. inlet	Pressure at entry to engine	Temp. at entry to engine	Temp. after leaving valve	Pressure at turbine inlet	Temp. at turb. inlet	Temp. at turb. outlet	
	hr.	B.H.P. (metric)	r.p.m.	kg./cm.^{2}	gr./B.H.P.-hr. (metric)	°C	mm./Hg.	°C	°C	mm./Hg.	°C	°C	r.p.m.
10% *Overload*													
increased m.e.p.	$\frac{3}{4}$	2625	750	12.07	169.2	5.0	604	78.7	498	310	611	504	11700
increased speed	$\frac{1}{4}$	2590	825	10.75	172.7	3.9	636	79.4	485	348	596	492	11800
Partial load	$2\frac{1}{2}$	2050	700	10.1	162.5	2.4	364	49.7	454	188	547	460	9600
	$2\frac{1}{2}$	1460	600	8.4	159.9	—0.3	194	28.4	403	96	491	422	7050
	$2\frac{1}{2}$	980	500	6.76	158.0	—0.8	98	14.4	354	51	419	366	5160
	$2\frac{1}{2}$	490	400	4.22	165.4	—3.0	36	5.0	268	29	294	263	3250

Alternating Load For 9 hours the engine was run intermittently for 6 minutes at nominal load and 4 minutes at no-load; the speed being 750 revs. per min.

Oil consumption at full-load = 1.8 gr. per B.H.P.–hr.

RAILWAY ELECTRIFICATION IN INDIA

FRENCH RAILWAY EXPERTS TO ADVISE

A Team of French railway experts is expected to visit Bombay State in the third week of July, in connection with the electrification of the Igatpuri-Bhusawal section of the Central Railway, which is under consideration.

The team came out to India some time ago, following an offer by the French Government. Under the terms of this offer, all expenses on the team, including travel from and to France, are being met by the French Government. The team is expected to advise the Indian railway authorities on certain technical aspects of electrification.

The team is led by Mr. F. Nouvion, renowned railway electric traction expert, who was connected with the running of the world's fastest electric train at 205 miles per hour in France a few months ago. Mr. Nouvion is Chief Engineer, Electric Traction, French National Railways. Other members of the team are Mr. J. Boulongne, Project Engineer, Mr. A. Crepet, Overhead Lines Engineer, Mr. M. Miot, Tract Engineer, and Mr. A. Lemaire, Communication and Signalling Engineer.

During his recent visit to Europe, Shri P. C. Mukerjee, Member (Engineering), Railway Board, discussed the team's visit to India with Mr. Armond, Chairman of the French National Railways, who is himself an outstanding engineer.

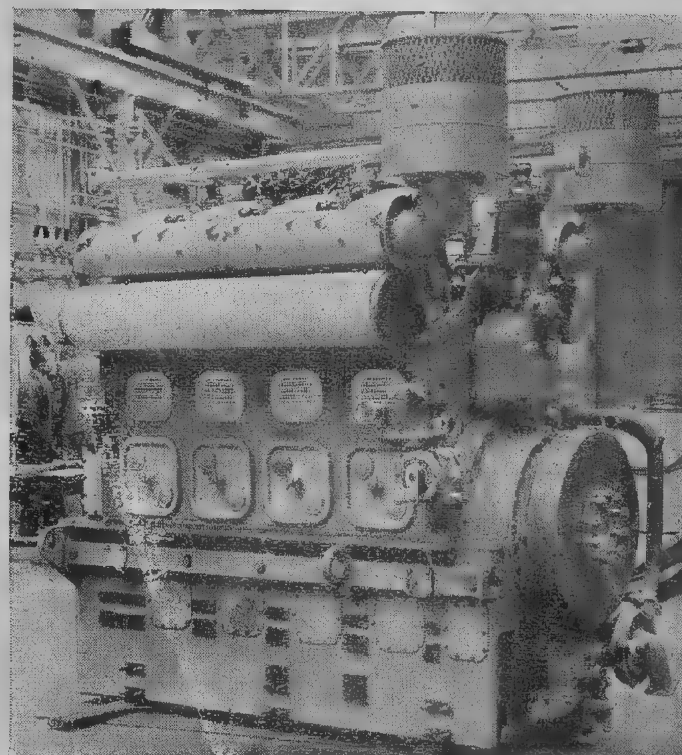
The team has already held discussions with the Railway Board and the General Managers and various experts of the Central, Western, Eastern and South Eastern railways. They have also carried out an inspection of the rail sections in the eastern region which are being considered for electrification. These are Asansol-Sini-Rourkela section on the South Eastern Railway and the Asansol-Gaya-Moghalsarai section on the Eastern Railway.

The leader and another member of the team have gone back to France after the preliminary survey. The former is expected to return to India some time in August.

INTRODUCING THE PAXMAN YL ENGINE

A range of railway diesels up to 2,000 h.p.

AN event of major importance to the British diesel traction industry for home and export markets is the introduction of a series of engines from 710 to 2,000 h.p., of proved design and performance, by Davey, Paxman & Co. Ltd.



This new design is the synthesis of all Paxman rail traction experience from the first 400 h.p. unit in 1931, and has the advantage of much experience gained over a speed range of 750 to 1,750 r.p.m., with welded steel, cast iron, and both cast and welded light alloy framing; high-speed light weight and medium-speed medium-weight construction; Ricardo heads and direct injection; and also the vast and varied experience from 7000 V-type engines of 500 h.p. placed in service. But this new design has two other things. First, the most modern machinery and production technique is available, and backed up by an independent quality-control department reporting to the managing director; secondly, when getting out the prototype design in 1950 the designers took full advantage of the then new silicone viscous vibration damper, which has revolutionised the approach towards problems of torsional vibration.

After many thousands of hours of running with prototype engines at high loads, and the revision of design of certain constituents, the commercial models have been introduced to the world railway market in five different models having all-welded steel framing.

Needs of high power and low fuel consumption resulted in four-valve heads and direct injection. Paxmans have been using the fork-and-blade type of connecting rods since 1937 and from their past experience have evolved the YL engine connecting rods which have proved to be entirely satisfactory. The short stroke-to-bore ratio of $9\frac{3}{4}$ in. by $10\frac{1}{2}$ in. cylinders was adopted to assist robust construction of the main framing in conjunction with a piston speed of 1,750 ft. per min., which is moderate for a large 1,000 r.p.m. model. Nor is the brake mean pressure of 126 lb. per sq. in. of the pressure-charged engine unduly high, and can well be carried continuously by the pistons, rods, bearings and framing. Finally, the weight and dimensions are well in line with the present-day requirements for large main-line locomotives weighing 115 to 125 lb. per b.h.p., the specific weight of the engines themselves being $19\frac{1}{2}$ to 28 lb. per b.h.p.

The engine gives the speed and pressure figures quoted above, and equal to 125 b.h.p. per cylinder, with an exhaust which is invisible over the whole working range from low fractional loads up to 10 per cent overload, and with an exhaust temperature not exceeding 520 deg. C. Further, the maximum firing pressure is of the order of only 950 lb. per sq. in. Fuel consumption is good and extremely even, varying only between the limits of 0.385 and 0.375 lb. per b.h.p.hr. all the way from 50 to 100 per cent load.

At the moment 8-, 12-, and 16-cylinder YL engines are being offered, either naturally-aspirated or pressure-charged on Buchi principles, and have the characteristics shown in the accompanying table. The b.h.p. and speed figures given are the maxima to which the engines are set, but are, in effect, the continuous ratings.

greater strength

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OVER 11,000 of these sturdy, all-steel, 16-ton mineral wagons are Pressed Steel built to the order of British Railways every year.

STRENGTH of construction means length—of service. Fewer running repairs or maintenance, longer operative life, greater economy in the long run. Pressed Steel Company Limited, one of Britain's greatest engineering organisations, build steel wagons and rolling stock . . . many thousands strong . . . for world railways.

Pressed Steel Company Limited are manufacturers also of Motor Car Bodies, Prestcold Refrigeration Equipment and Pressings of all kinds.

Notable features of the machanical design include extreme lateral and vertical rigidity of the framing; the provision of separate galvanised water jackets round each cylinder liner to keep the cooling water from the welded steel frame; four-valve heads with specially-divided inlet ports to give uni-directorial swirl and good combustion; and a very high degree of standardisation of parts, about 75 per cent of all wearing constituents being both standard and interchangeable between the five engines in the YL range, so that one stock of spares will meet all a railway's requirements from a heavy shunter to the largest main-line classes.

CHARACTERISTICS OF PAXMAN YL AND YLX ENGINES

Model	N. A. or P. C.	B. H. P.	Cyl. bore & stroke in.	R. P. M.	Brake mean pressure lb./sq. in.	Piston speed ft./min.	Dry weight lb.	Dry weight lb./b.h.p.	Gross weight with water & oil—lb.
8YL	N. A.	710	$9\frac{3}{4}\times10\frac{1}{2}$	1,000	90	1,750	20,300	$28\frac{1}{2}$	21,300
12YL	N. A.	1,070	$9\frac{3}{4}\times10\frac{1}{2}$	1,000	90	1,750	27,700	26	29,100
8YLX	P. C.	1,000	$9\frac{3}{4}\times10\frac{1}{2}$	1,000	126	1,750	22,300	$22\frac{1}{4}$	23,300
12YLX	P. C.	1,500	$9\frac{3}{4}\times10\frac{1}{2}$	1,000	126	1,750	29,200	$19\frac{1}{2}$	30,600
16YLX	P. C.	2,000	$9\frac{3}{4}\times10\frac{1}{2}$	1,000	126	1,750	38,700	$19\frac{1}{2}$	40,500

N. A. = Naturally aspirated. P. C. = Pressure charged.

LIFE AND CULTURE OF SOVIET RAILWAYMEN

THE culture of Soviet railway workers is growing and their technical and general-education level is rising with each passing year.

The USSR railways now have 14 schools of higher learning training 40,000 students, 74 specialized technical schools, hundreds of vocational and thousands of elementary and secondary schools; their number will considerably increase during the current five-year plan. The railways also have 856 clubs, palaces and houses of culture, 13,000 recreation rooms (red corner) and 2,500 libraries.

Ever larger funds are appropriated for the social insurance and health of the railwaymen. More than 5,000 million rubles were spent for these purposes in 1955 alone. Over 220,000 railway workers spent their vacations in sanatoria and rest-homes. Twice as much money has been allotted to the medical service of the railwaymen during the current five-year plan as compared with the last; the number of kindergartens will increase four-fold and that of creches—three-fold. The social insurance budget will exceed 2,600 million rubles in 1956.

"CASH YOUR IDEAS" SCHEMES FOR RAILWAYMEN

SENIOR officers of each Railway Administration in the country are to be associated with the "Cash Your Ideas" schemes, under which all grades of staff, gazetted or non-gazetted, are encouraged to come forward with constructive ideas for improving the working of the railways.

The Railways have been requested to publicise the fact widely that they would be glad to consider any inventions or constructive suggestions from members of their staff belonging to all ranks. Monetary rewards are given to those responsible for useful suggestions which are found acceptable.

A high-powered five-member Standing Screening Committee (Inventions and Suggestions) already exists at each Railway headquarters. In future, the Senior Deputy General Manager of each zonal Railway will preside over this committee. Railway Administrations which do not have a Senior Deputy General Manager would post other senior officers to guide the deliberations of this committee.

The Railways have been requested to ensure that the screening committees normally meet once a month. The fact that an employee has made an acceptable suggestion would be recorded in his personal file and would be a factor in his favour at the time of promotion to a higher post.

The Railway Board has requested the Railway Administrations to ask senior officers to personally hand over awards to employees, to give them the feeling that the Administrations attach great importance to constructive thinking on the part of their staff.

Internal Lubrication of Steam Locomotives

[Contributed by Caltex (India) Limited]

THE proper choice and use of lubricants forms an indispensable part of the steam locomotive. The lubricant in a bearing serves as important a duty as the metal surface of the bearing itself, which would promptly 'burn out' if no lubricant were present. Not only is excessive were produced in a steam cylinder by lack of lubrication but also steam leakage results. The long life and service rendered by any machine or moving part is entirely dependent upon the selection of correct lubricants. Correct lubrication is the prime factor of profitable railway operation. Due to the economy of correct lubricants these benefits are secured at little or no increase of cost per mile of operation.

The investment involved in the locomotives of any road is necessarily large. Returns from this investment are largely dependent upon correct lubrication, which lengthens the life of every engine, reducing the rate of depreciation. Maintenance costs are largely due to necessary repairs of the worn parts. Correct lubrication reduces wear to a minimum.

Let us here consider the internal lubrication of locomotives in terms of valves and cylinders.

Internal lubrication of the locomotive has two main purposes :—

1. To reduce friction and wear of valves, valve seats, valve stems, pistons, cylinder walls, and piston rods, to a minimum.

2. To provide an effective oil seal for all these parts to resist steam leakage.

Effective internal lubrication is the result of a series of conditions, each one of which must be favourable if the best results are to be obtained. The oil must be introduced at the proper place and in the correct amount. It must be adequately yet uniformly, distributed or spread over the surfaces to be lubricated. The oil must be adapted to the method of introduction, and distribution, and must possess all of the characteristics required for its functions as a Lubricant and sealing medium, and must resist whatever film-destroying conditions are encountered.

If water condensation is present, the oil must still adhere to the surfaces and form a satisfactory film in spite of this condition. Steam temperatures, and temperatures of lubricated parts, are influenced by operation while drifting, which may produce conditions extremely adverse to correct lubrication. Soot and cinders may be unavoidably drawn into the cylinder from the smoke box, while the oils must still maintain lubrication.

The factors which influence the selection of locomotive steam valve or cylinder oils are as follows :—

1. Quality of steam in valve chest and cylinder which may be wet, saturated or superheated – in the latter case, the governing figure being the total temperature, i. e. the saturated steam temperature plus the degrees of superheat.

2. Method of application, which may be by hydrostatic or mechanical lubricator to one or more of the following points :—

   (a) Steam pipe above valve chamber.

   (b) Valve chamber.

   (c) Upper part of cylinder wall.

   (d) Lower part of cylinder wall.

3. Service – long run road service, or suburban service or shifting service.

Diameter of cylinder is also a factor influencing the distribution of oil, and the quantity of oil required.

MAIN STEAM VALVES AND CYLINDERS

Speed and load are extremely variable. While in some classes of service a high speed may be maintained

over a long run, the load may at the same time vary from maximum at starting and on an upward to no load on a downward grade and while slowing for a stop. Speed and load variations have a strong modifying influence on steam quality from time to time.

Steam quality – set, dry or superheated – is a factor which influences the choice of the oil for valve and cylinder lubrication. So long as the degree of superheat is not extreme, there are always times where there is a condensation in the steam cylinders resulting from light loads and the automatic cut-out of the superheater by the action of the damper during certain conditions of operation or stopping. Even when a high degree of superheat is used, the variable operating conditions will at times result in condensation in the cylinders. With high superheat, and long continuous runs, however; there may be justification for the use of an oil of a body heavier than would otherwise be used.

There are two classes of lubricators employed for the introduction of valve or cylinder oil to the internal parts of a steam locomotive, namely, (1) the hydrostatic lubricator, (2) the mechanical force feed lubricator. Both types of lubricators give excellent service and the choice between them is often difficult.

The hydrostatic lubricator is located in the cab of the locomotive, and is at all times in view and under the control of the engine men. The operation of the lubricator depends upon the oil within the lubricator being displaced by water condensed from steam, which is admitted by a pipe leading from the boiler. The flow of oil is controlled by the adjustment of needle valves.

When a mechanical force feed lubricator is used, it is located near the locomotive cylinders, and consists of an oil reservoir, with several diminutive, positive-acting plunger pumps, which are mechanically operated by a mechanism operated from some moving part of the engine. The plunger pumps are so designed that the quantity of oil discharged can be regulated. After adjustment, this type of lubricator requires no further attention than filling.

It should be observed that the hydrostatic lubricator feeds oil uniformly with respect to time, i. e., a constant number of drops per minute, and that, therefore, an

engine running at high speed receives less oil per revolution than when running at relatively low speed, unless re-set by engine-man.

The mechanical force feed lubricator, on the other hand, may be made to feed oil at a constant rate with respect to the revolutions of the driving wheels, i. e., to feed one drop of oil for every so many strokes of the piston. Relatively speaking, this type of lubricator then supplies more oil when the engine is running at high speeds than does the hydrostatic lubricator. By driving the lubricator from a part of the valve gear that has a variable motion, the rate of feed may be made to vary accordingly.

Drifting operation that permits access of cinders from the smoke box to the cylinders is a condition that renders satisfactory lubrication exceedingly difficult. Oil is a binder of the impurities which can only be made more serious by the use of an oil of unusually heavy body. It is frequently the practice to keep the throttle slightly opened when the engine is drifting in order to provide steam to atomize the oil, also to avoid drawing in cinders from the smoke box.

The great majority of locomotive operating conditions call for the use of cylinder or valve oil, which has a body sufficiently light to assure atomization. Whenever extreme water conditions prevail, a compounded oil should be used. The compounding of this oil renders it a very adhesive lubricant, capable of maintaining a lubricating and sealing film in spite of moisture resulting from cylinder condensation and has long-lasting qualities.

The locomotives operating on long, continuous runs in which a heavy load predominates, the use of highly superheated steam sometimes calls for the use of an extra heavy bodied oil for which service Caltex 474 Mineral Superheat Valve Oil (G/o–101/33) is recommended, due to its high lubricating value, heavy body and special quality indicated in high temperature conditions.

STEAM REVERSING CYLINDERS

Steam cylinders of power reversing gears require but a small amount of cylinder oil to accomplish lubrication. The same Cylinder Oil as is used for main cylinders

should be applied by means of the oil cups or other fittings provided for the purpose.

AIR CYLINDERS OF REVERSING GEAR

Where power reversing gear is operated by air cylinders, good lubrication and an effective piston seal can be maintained by the application in the shop of Caltex Petroleum Jelly by means of a compression cup or through the gland.

STEAM CYLINDERS OF STROKE ENGINES AND LOCOMOTIVE AIR PUMPS

These steam cylinders are lubricated by feeds from a hydrostatic or force feed lubricator. The same Cylinder Oil should be used for this purpose as is applied to the steam cylinders of the locomotive.

AIR CYLINDERS OF LOCOMOTIVE AIR PUMPS

The temperature in these air pump cylinders resulting from air compression is high, requiring the use of a heavy bodied oil. It is recommended that the same Cylinder Oil be used here as is applied to main steam cylinders. Several types of special oil cups and air pump lubricators are employed for this purpose.

AIR BRAKE LUBRICANT

The lubrication of these cylinders requires a special lubricant which will stay in place and maintain lubrication and piston seal from one shop inspection to the next. Caltex 904 Grease Graphite has been developed specially for this purpose and should be applied in the shop to the cylinder walls in a uniform thin coat by swabbing.

TRIPLE VALVES

The correct lubrication of triple valves requires care in application of the lubricant as well as its correct selection. There is a difference of opinion as to the relative desirability of a grease or an oil for this purpose. Where a grease is desired Caltex 904 Grease Graphite is recommended. The correct oil for this purpose is Caltex 754 Oil (G/0-101/44). These lubricants are adapted to resist the effects of low temperatures. In either case, the frictional surfaces should receive an extremely light application of the lubricant at the time of shop inspection. The use of either of these lubricants and the observance of the precaution regarding application will assure the free operation of the triple valve at all times and will guard against clogging any of the parts of openings.

INDIAN CONTRACT AWARDED

To improve communications in the central and suburban areas of Calcutta it has been decided to electrify certain sections of the Eastern Railway. Work on the first stage, covering the main line between Howrah and Burdwan and the branch line to Tarakeswar, has begun. British Insulated Callender's Cables Ltd., in conjunction with their associates the Indian Cable Co. Ltd., have been awarded the contract for the supply and installation of the underground power and control cables.

The total value of this contract is in the region of £250,000 and is for 33kV, 11kV and 3.3kV paper insulated feeder power cables, also 245 miles of control cable.

ELECTRIC FURNACES

THOUGH furnaces, in one form or another, have been known and have been progressively developed ever since man began to use cast and wrought metals, it is little more than thirty years ago since electric heating began to be used for such purposes on an industrial scale. Since that time, electric furnaces have been designed for almost the entire field of heating operations encountered in the engineering and metallurgical industries, from the refining of the crude ore to the heat treatment of the finished product. Within this wide range, the variety of different designs which has been produced is so extensive as to defy analysis in any but the broadest terms.

The Electric Smelting Furnace for the reduction of metallic ore is, perhaps, the biggest member in this variegated class, both in terms of physical dimensions and electric power rating. At the other end of the scale are the small resistance furnaces used for tool hardening or for Laboratory purposes. Between these extremes are included the Arc Furnaces used for metal melting in the production of castings or ingots and the larger resistance furnaces which are employed for the annealing, hardening or other treatment of the wrought metals produced from ingots by rolling, forging and other processes. Not to be forgotten moreover, is the Induction Heating process, though the equipment which it employs may often escape any attempt at defining an electric furnace.

It is possible to classify Electric Furnaces in three broad groups, according to the means by which heat is imparted to the product. In one group, for example, the charge is heated by passing an electric current directly through it, between suitable electrodes and both smelting furnaces and direct-arc may logically be regarded as members of this group, though they do, in fact, involve some degree of radiation heating also. A second class also employs electric currents flowing through the material to be heated but these currents are generated by electro-magnetic induction without any direct connection between the charge and the power source. Induction Heating and Melting Furnaces are typical examples.

The third classification – which probably represents the vast majority of electric furnaces – depends on the transfer of heat from a hot body to the charge by conduction, convection, radiation or a combination of such methods. Loosely described as "Resistance furnaces", these usually employ heating elements of suitable high temperature material which are connected to the electric power supply and which are so disposed around the charge as to impart to the latter the heat generated in them by the passage of current. The resistance elements themselves are most usually made of a nickel-chromium alloy in the form of ribbon of wire but silicon carbide rods and other refractory materials may be used is appropriate cases or even a crucible of molten salts, into which the work is immersed.

The commonest type of Electric Resistance Furnace has a heating chamber built of refractory bricks, on the walls, roof and floor of which are mounted heating elements of nickel chromium ribbon. The floor or hearth elements are protected by nickel chromium plate on which is placed the work which it is desired to heat. For operation at temperatures above about 700°C, heat radiation from the elements onto the work is usually the main factor in heating the latter but at lower temperatures the furnace atmosphere may be agitated by a motor driven fan to provide, in effect, forced convection heating. Such a furnace may be designed to operate with the chamber filled with artificially-produced gases for the purpose of excluding air and thereby preventing the formation of oxide on the work which is undergoing treatment.

To these basic essentials of a Resistance Furnace may be added many special features, including conveyor mechanism to carry the material into and out of the heating chamber. On discharge from the heating chamber, the material may be allowed to cool down naturally (when some oxidation will be caused) or it may be transferred quickly to a tank of oil or water to give the rapid cooling or "quenching" which is required in certain processes. Again, a cooling chamber may be connected to the furnace and filled with the same protective gas, conveyor mechanism transporting the work from one to the other.

Any attempt to describe the Industries and Industrial Processes in which electric furnaces are used can be undertaken, for practical reasons, only in terms of general categories. Starting again with smelting furnaces, for example, it can be said that these have been successfully applied to the processing of a number of ores, including iron and nickel, copper, tin. When the ore has been reduced to metal, it may be cast into ingots or subjected to further metallurgical processing before taking a form suitable for working into sheet, strip, bar or tube. Electric Arc Furnaces or Induction Melting Furnaces are often used for the production of the billets from which such products are rolled or drawn.

In converting a metal billet into the commercial sheet, rod, etc., further heating operations are usually involved. Electric Induction Heating is applicable here and is growing rapidly in importance in this field. The initial product of the mill, however, usually undergoes cold-working operations before attaining its final state and it is usual to anneal or soften the material at various stages during these operations, for which purpose electric resistance furnaces are commonly employed.

Engineering fabricators operate on the material so produced to form finished articles of innumerable different kinds. The fabricating operations often involve further annealing in electric furnaces while, in the case of steel parts destined for use in machinery, hardening to give the parts adequate wear resistance or spring qualities offers further wide scope for electric furnaces.

Both in the primary processes used for producing strip, tube, wire, etc, and in the fabricating processes by which these materials are turned into finished articles, tools of all kinds are employed. The majority of such tools are made of steel which requires to be hardened in order to give it a long working life under arduous conditions and electric furnaces are widely accepted as the best means for performing such hardening operations.

Primarily, the rapid growth of electric furnaces throughout Industry—where they are daily replacing fuel-fired furnaces to an increasing extent—derives from the superior uniformity of heating and accuracy of control which they provide. Electric power is not subject to the variations which beset many forms of fuel,—variations in analysis, in pressure, etc.—and thus permits the standardization of processing schedules which is an essential feature of modern production planning.

Not all the districts in which Industry is growing, moreover are adequately supplied with reliable, combustible fuels. On the other hand, no Industry can now operate without electric power in some form or other and, apart the technical considerations just mentioned, electric furnaces, therefore have the great value of convenience in installation wherever the supply lines run. With the expected advent of atomic power, it is safe to predict that electricity will be virtually the Universal medium for Industrial energy and furnaces consuming raw fuel may become things of the past.


BETTER.
JAI HIND
INDIAN RAILWAYS

Recent progress on Japanese Railways

IT might be some interest to you to recognize the general idea of the recent progress on the railways in Japan through illustrations of many kinds of vehicles built in the latter years.

STEAM LOCOMOTIVE

With the recent tendency taken by most of the countries throughout the world, production of steam locomotive of the Japanese National Railways (J.N.R.) has never taken place since 1948. Fig. 1 shows class E 10, the last class of newly built on the J. N. R. The locomotives were made for the heavy gradient section of Itaya Pass (later electrified). After the completion of class E 10 locomotives, new classes of steam locomotives, C 61, C 62, D 60, D 61 and D 62, appeared on the J.N.R., but all of those were of converted ones, but not of newly built. Class C 62 shown in Fig. 2 is the representative among those converted locomotives, that is to say, the locomotives were converted from 2—8—2 type freight ones to 4—6—4 type for express passenger service. The locomotives weigh 143 tons in working order and are fitted with a mechanical stoker, which was specially built in small size to suit to a narrow gauge locomotive. (Fig. 3)

Due to the blank of newly building of steam locomotive on the J.N.R. for nearly ten years, considerable numbers of the medium size locomotives are wanted since two or three years ago. To satisfy the said request, the design for the mixed traffic locomotives of 2—6—2 type was completed last year. (Fig. 4) The

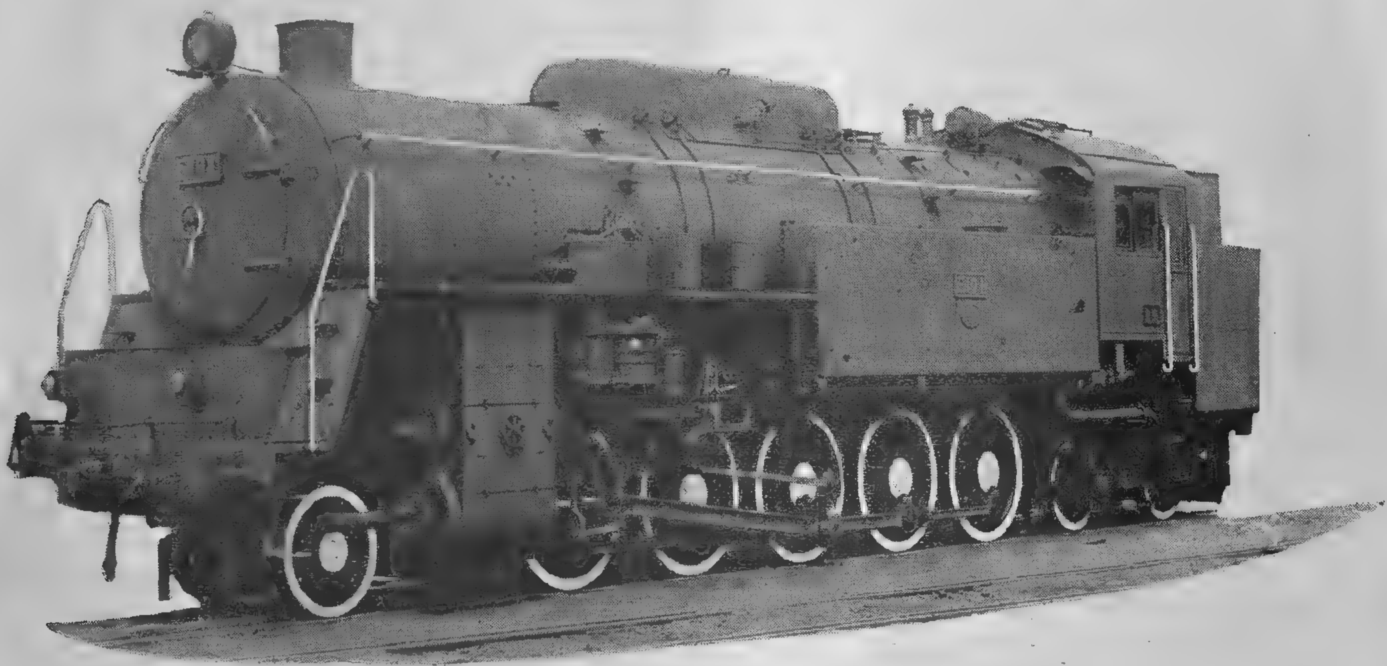


Fig. 1. 2–10–4 type tank locomotive for heavy gradient section of J. N. R.

GENERAL DIMENSIONS

Gauge of Track	1,067 mm	3′–6″
Dia. of Cylinders	550 mm	1′–9⅝″
Stroke of Pistons	660 mm	2′–2″
Dia. of Leading Truck Wheels	860 mm	2′–9⅞″
Dia. of Trailing Truck Wheels	860 mm	2′–9⅞″
Dia. of Driving Wheels	1,250 mm	4′–1¼″
Driving Wheel Base	5,800 mm	19′–⅜″
Total Wheel Base of Engine	11,600 mm	38′–⅝″
Dia. of Boiler (Out. Dia. of 1st. Ring)	1,808 mm	5′–11⅛″
Tubes (Dia.–No.)	57 mm–74	2¼′–74
Flues (Dia.–No.)	140 mm–75	5½′–35

Heating Surface of Tubes & Flues	131.3 m^2	1,414 ft^2
Heating Surface of Firebox	14.4 m^2	155 ft^2
Superheating Surface	77.4 m^2	834 ft^2
Total Heating Surface	223.1 m^2	2,403 ft^2
Grate Area	3.3 m^2	35.5 ft^2
Working pressure	16kg/cm^2	228 lb/in^2
Weight of Engine in Working Order	100,300 kg	221,160 lb
Weight on Driving Wheels	70,000 kg	154,350 lb
Tank Capacity	8.3 m^3	282 ft^3
Fuel Capacity	4,000 kg	8,820 lb
Tractive Power $= \dfrac{0.85\, Pd^2 s}{D}$	21,700 kg	47,850 lb

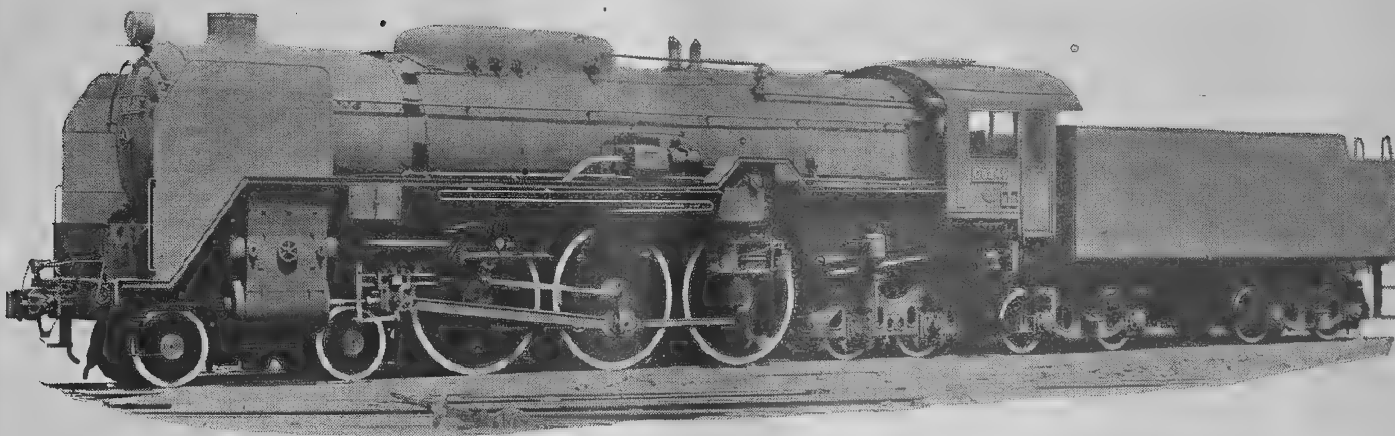


Fig. 2. 4–6–4 type express passenger locomotive for J. N. R.

GENERAL DIMENSIONS

Gauge of Track	1,067 mm	3'–6"
Dia. of Cylinders	520 mm	1'–8½"
Stroke of Pistons	660 mm	2'–2"
Dia. of Leading Truck Wheels	860 mm	2'–9⅞"
Dia. of Trailing Truck Wheels	860 mm	2'–9⅞"
Dia. of Driving Wheels	1,750 mm	5'–8⅞"
Driving Wheel Base	3,800 mm	12'–5⅝"
Total Wheel Base of Engine	10,520 mm	34'–6⅛"
Total Wheel Base (Eng. & Tender)	19,000 mm	62'–4"
Dia. of Boiler (Out. Dia. of 1st. Ring)	1,808 mm	5'–11⅛"
Tubes (Dia.-No.)	57 mm–94	2¼"–94
Flues (Dia.-No.)	140 mm–35	5½"–35
Heating Surface of Tubes & Flues	147.4 m^2	1,587 ft^2
Heating Surface of Firebox	19.7 m^2	212 ft^2
Superheating Surface	77.4 m^2	833 ft^2
Total Heating Surface	244.5 m^2	2,632 ft^2
Grate Area	3.85 m^2	41.5 ft^2
Working Pressure	16 kg/cm^2	228 lb/in^2
Weight of Engine in Working Order	87,070 kg	191,990 lb
Weight on Driving Wheels	48,600 kg	107,160 lb
Tank Capacity	22 m^3	777 ft^3
Fuel Capacity	10,000 kg	22,050 lb
Weight of Tender in Working Order	56,000 kg	123,480 lb
Weight of Eng. & Tender in Working Order	143,070 kg	315,470 lb
Tractive Power $= \frac{0.85 Pd^2 s}{D}$	13,900 kg	30,650 lb

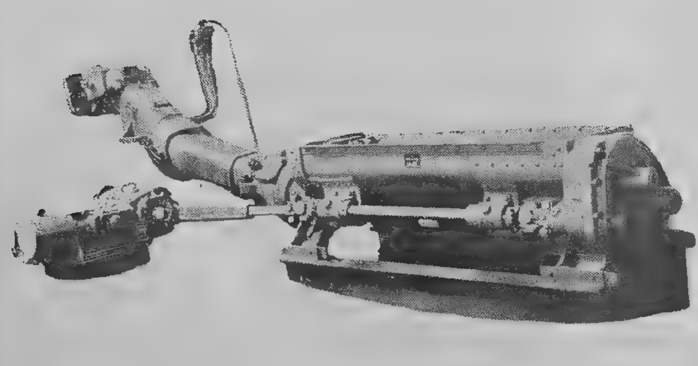


Fig. 3. Mechanical stoker specially designed for narrow gauge locomotives.

boiler of the locomotives is of all welded construction with a U shaped foundation ring and some of the locomotives will be fitted with roller bearings on all of the journal boxes and crankpins. However, any locomotive of this class has never been materialized due to the influences of the electrification and dieselization of the National Railways.

ELECTRIC LOCOMOTIVE & CAR

In Japan, due to lack of oil resources and high price of coal, the electrification takes the priority in the railways. Thus the large amount of electric locomotives were built after the World War II. They occupy bigger portion than any other kinds of locomotives newly built after the War.

There are two classes of the representative electric locomotives on the J. N. R.; classes EF 58 (Fig. 5) and EH 10 (Fig. 6). The former is of 2B-B2 type 113 tons, 2550 h.p. for passenger service and is installed with a set of steam generator for train heating purpose which is illustrated in Fig. 7. The steam generator is of monotube type with fully automatic control device and has the evaporative capacity of 1750 lbs. per hour.

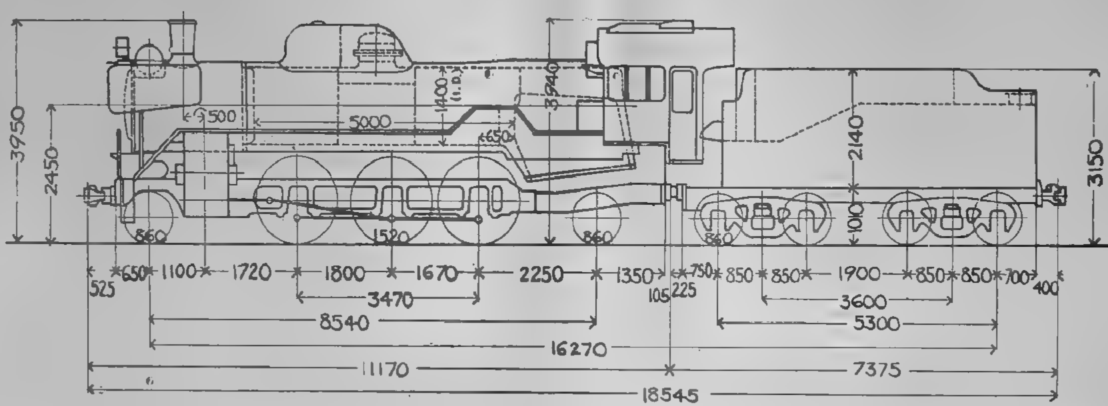
The latter locomotive of B-B-B-B type for freight service is composed of two units in permanently-coupled. The locomotive has 3340 h.p. and weighs 116.5 tons.

No. 722

C63

2-6-2 TYPE TENDER LOCOMOTIVE WITH SUPERHEATER

KISHA SEIZO KAISHA LTD.



GAUGE OF TRACK	3' - 6"	WATER CAPACITY	4,500 GALLS
NO. OF CYLINDER	2	FUEL CAPACITY	7.87 TONS
DIA. & STROKE OF CYLINDERS	1'-5¾" x 2'-0"	DIA. OF WHEELS, DRIVING	4'-11 ⅞"
WORKING PRESSURE	256 LBS/□"	LEADING TRUCK	2'-9 ⅞"
GRATE AREA	25.8 SQ.FT	TRAILING TRUCK	2'-9 ⅞"
HEATING SURFACE, TOTAL	1642.6 "	TENDER TRUCK	2'-9 ⅞"
SUPERHEATING	444.6 "	WEIGHT OF ENG. IN WORKING ORDER	61.25 TONS
EVAP., TOTAL	1,198.0 "	ON DRIVING WHEELS	40.74 "
TUBES & FLUES	1078.5 "	ON LEADING TRUCK	8.22 "
ARCHTUBES	10.8 "	ON TRAILING TRUCK	12.29 "
FIREBOX	108.9 "	WEIGHT OF TEND. IN WORKING ORDER	44.33 "
DIA. OF BOILER (INSIDE)	4' - 7⅛"	WEIGHT OF ENG. & TEND. IN WORKING ORDER	105.58 "
TUBES (DIA. x LENGTH x NO.)	2¼" x 16'-4⅞" x 73		
FLUES (" x " x ")	5½" x 16'-4⅞" x 20	TRACTIVE POWER $\frac{0.85\,Pd^2S}{D}$	27,450 LBS
MAXIMUM WIDTH	9' - 7"		

Fig. 4. Diagram of locomotive, class C 63, designed for mixed traffic service of J.N.R.

Fig. 5. Class EF 58, 2 B-B 2 type 2550 h.p. electric locomotive for passenger service of J.N.R.

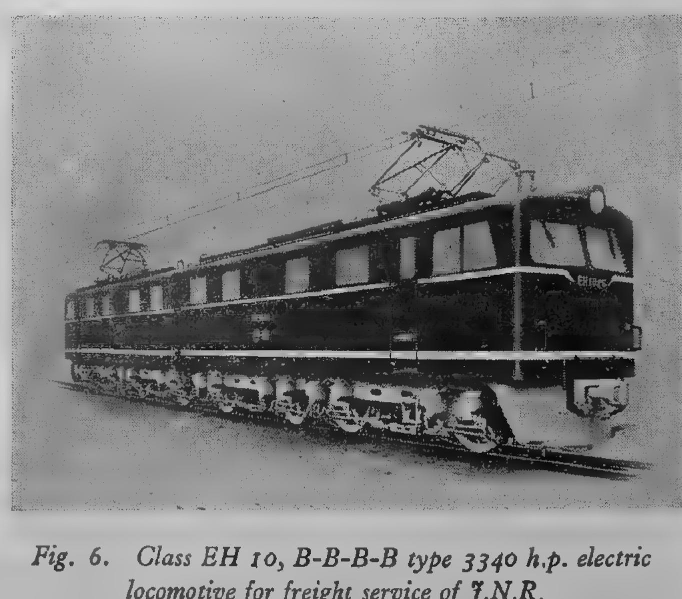


Fig. 6. Class EH 10, B-B-B-B type 3340 h.p. electric locomotive for freight service of J.N.R.

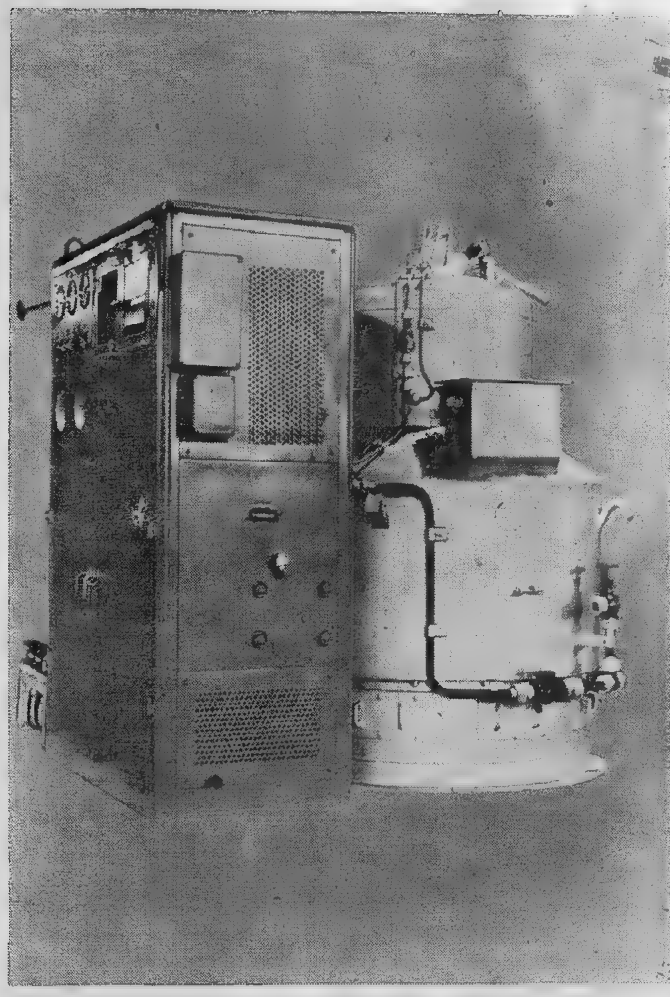


Fig. 7. Steam generator for train heating, installed on class EF 58 electric locomotive.

The generator is of fully automatic control.

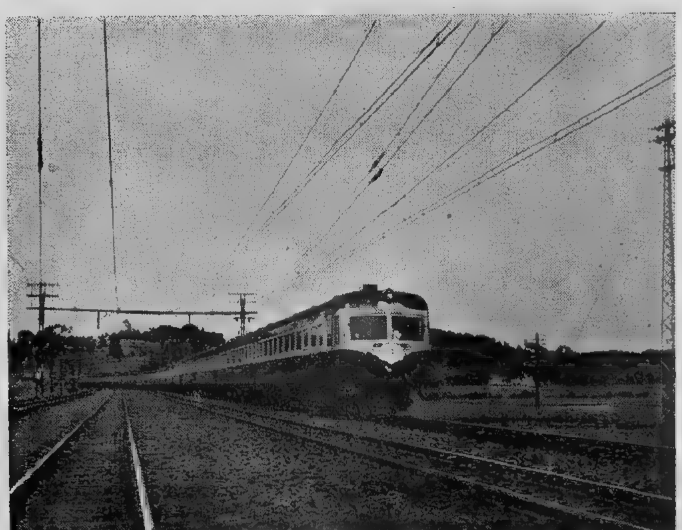


Fig. 8. Multiple-unit train used in Tokyo area of J.N.R. The train is composed of 15 cars.

Fig. 9. One of multiple unit trains built for express service between Tokyo and Nikko, Tobu Railway.

Fig. 10. Electric car built for operation of Tokyo Underground Railway.

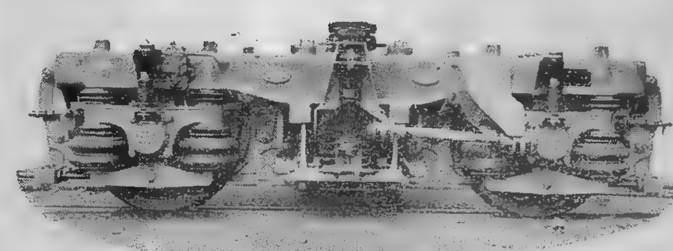


Fig. 11. Bogie with air spring used on electric car for KEI-HAN Electric Railway.

LEFT :

Fig. 12. Four-car diesel unit built for operation on secondary line of J.N.R.

BOTTOM :

Fig. 13. 320 h.p. B-B type diesel-hydraulic locomotive for switching service of J.N.R. (class DD 11).

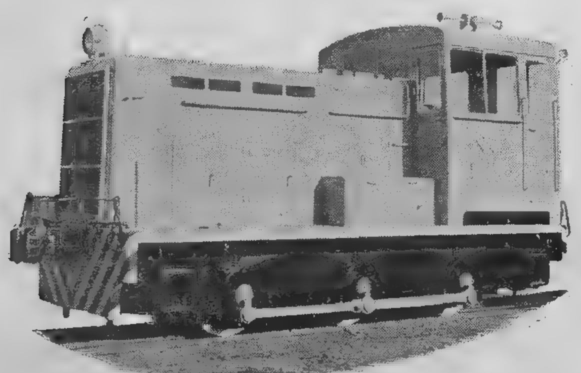


Fig. 14. One of the builder's standard design 25 ton, 160 h.p. diesel-hydraulic locomotives for industrial purpose.

Fig. 15. 35 ton, 300 h.p. diesel-hydraulic locomotive built for mixed traffic on Nambu Railway of Japan.

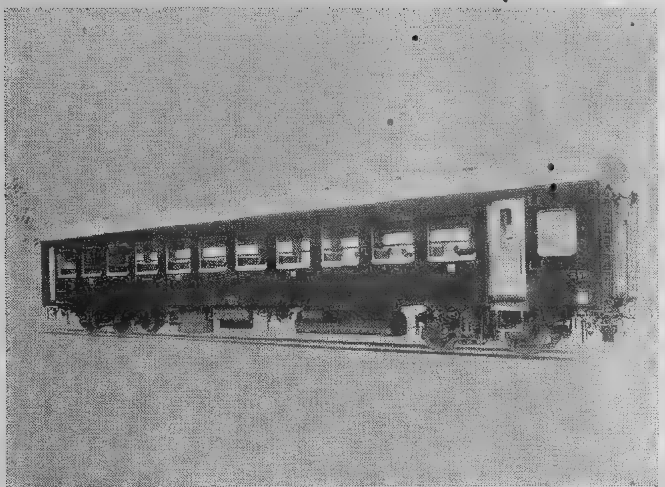


Fig. 16. Light weight, third class passenger car designed for operation on J.N.R.

Fig. 17. Interior of the passenger car, shown in Fig. 16.

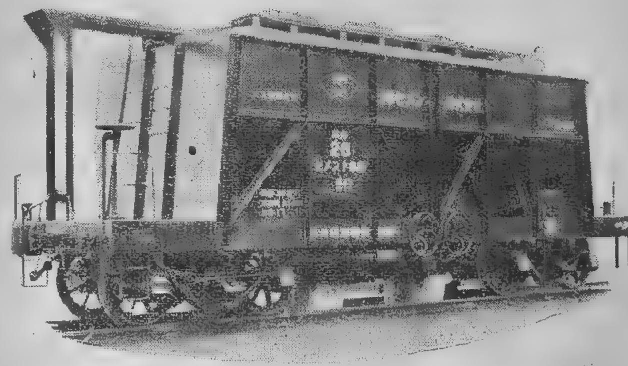


Fig. 18. Cement hopper car specially designed to transport cement.

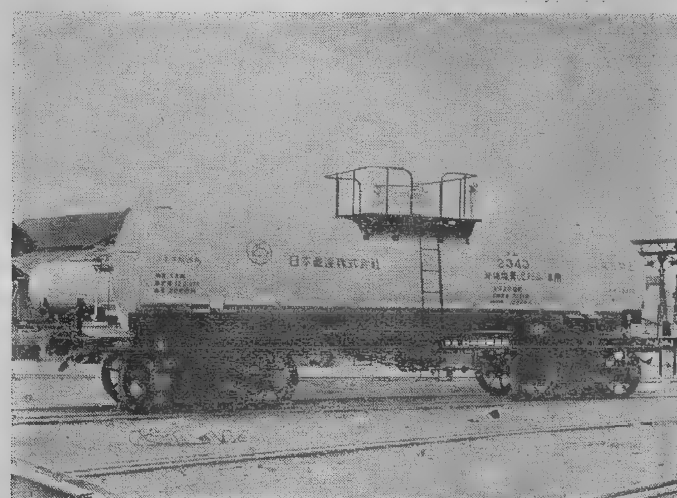


Fig. 19. One of special tank cars carrying liquid chlorine built for Nippon Soda Co.

Electric cars are also popularized throughout Japan, especially around big cities, such as Tokyo, Osaka & Nagoya areas. Not only the National Railways, but most of the big privately-owned railways apply electric cars, and those cars are proud of their up-to-date design both on the accommodations and on the mechanisms.

Most of the suburban and interurban electric cars are operated in multiple unit which are composed of from two cars upto as many as fifteen cars.

Fig. 8 shows one of the multiple unit trains composed of 15 cars. Those trains are operated on J. N. R. lines of Tokyo area.

Fig. 9 shows the newly built multiple unit train for Tobu Railway Co. The train is used for the express service between Tokyo and Nikko; the latter is one of the most scenic places in Japan. The cars are accommodated with reclining seats and a coffee stand.

The city transportation is also very busy both in Tokyo and Osaka. Those two cities have underground railways. One of the newly built electric cars of the Tokyo Underground Railway is shown in Fig. 10.

The notable characteristics on those modern electric cars in Japan are as follows:—

(a) Trains are composed of all motor cars for obtaining high acceleration and retardation, the latter can be secured by means of dynamic brake.

(b) Light weight in construction; about 30 tons per car of 60 feet length with four traction motors of 100 or 125 h. p.

(c) Fully sprung motors are applied instead of nose-suspension type. Power transmission is obtained by means of cardan shaft or flexible coupling between motor shaft and driving axle. The motors are of light weight and high speed.

(d) Truck or bogie is of all coil spring with shock absorber, and some of which will be applied air spring in the near future.

Fig. 11 shows an example of the truck with air spring, which was delivered to KEI-HAN (Kyoto-Osaka) Electric Railway.

DIESEL CAR & LOCOMOTIVE

As have mentioned in above article, the electrification holds the most important position on the Japanese railways, but the diesels are in more or less universal use throughout the country for railcars of new construction, particularly after the War. For local line operation these cars gain popularity by improved passenger service, while on one hand, operational expenses are saved. At the end of 1955, J. N. R. had 801 diesel coaches, some 550 units out of which were built within last four years. Furthermore, besides of J. N. R., some 300 units can be seen on the private railways.

Fig. 12 shows one of the representative diesel trains of J. N. R. All these cars of single-end type and are fitted with the Railways' standard engine of 160 h.p. and hydraulic transmission of the Lisholm Smith or Twin Disc types.

In regard to diesel locomotive, two classes were applied by J. N. R. Those are DD 50 DD 11; the former is of diesel-electric for passenger service on secondary lines and the latter is of diesel-hydraulic for switching purpose.

Diesel-hydraulic locomotives will be used more extensively in Japan due to cheapness in price and simplicity in construction. Fig. 13 shows class DD 11 diesel-hydraulic locomotive, the particulars of which are shown in Table I.

TABLE I

General Dimensions

Gauge of Track	1,067 mm	3′-6″
Wheel Arrangement		B-B
Diameter of Driving Wheels	860 mm	2′-10″
Rigid Wheel Base	2,000 mm	6′-6$\frac{3}{4}$″
Total Wheel Base	6,200 mm	20′-4$\frac{1}{8}$″
Total Length (Between Bumper Plates)	8,500 mm	27′-10$\frac{5}{8}$″
Maximum Width	2,510 mm	8′-2$\frac{7}{8}$″
Maximum Height	3,550 mm	11′-8″
Total Weight in Working Order	35,000 kg	77,200 lb
Type of Transmission	Hydraulic Torque Converter	
Diesel Engine	4 Cycle, 8 Cylinders, Straight Vertical	
Normal Output of Engine	2×160 HP (=320 HP)	
Normal Revolutions of Engine		1,500 rpm

Apart from J. N. R., uses of diesel locomotives on the private railways and industrial firms are rapidly increasing. Old steam locomotives are being replaced with diesel locomotives, which are generally of small size. Figs. 14 and 15 show those units. Fig. 14 is 160 h.p., 25 tons diesel-hydraulic locomotive for Nippon Semento Kaisha (Japan Cement Co.). Fig. 15 is 300 h.p., 35 tons unit for Nambu Railway of North Japan.

PASSENGER CAR

Much progresses have taken place on the design and construction of the passenger cars in the recent years. The progresses mean reducing the weight and increasing the comfort.

The former third class passenger cars of J. N. R., the width and length of which were 9 feet 2$\frac{1}{2}$ inches and 65 feet 7 inches respectively, weigh 33.5 tons. In 1955, J. N. R. completed a few of the specially light weight coaches shown in Fig. 16. The weight of these coaches is only 23 tons and yet the coaches have same width and length as of the former ones. Not only the weight of the coaches was reduced by means of all welded construction both on the superstructure and the bogies, but the accommodation was also much refined and improved. The inside panel was applied with hard-board covered by vinyl cloth in place of the former bare wood. Besides the inside panel, many wooden

(Continued on page 58)

The Reinforced Concrete Sleepers of the Vagneux System

By Paul Maille

Graduated from the Polytechnical School, President and Head Manager of the SATEBA.

THE use of reinforced concrete sleepers inceasingly goes on finding new adepts among the authorities in the field of railway technics. The SOCIETE ANONYME DE TRAVERSES EN BETON ARME SYSTEM VAGNEUX cannot help feeling a certain pride when seeing that the ideas that its founder, Mr. Edmond VAGNEUX, untirely has put forward and defended since 1914, have made their way and are now adopted in France as well as in other countries.

In fact, no experiment with reinforced concrete sleepers had ever been really successful, no one had led to a real utilization on a large scale, before the task was taken up by Mr. Edmond VAGNEUX, chief engineer of the department of "Highways and Bridges", later chief engineer of the French Railroads, creator of the system of reinforced concrete sleepers bearing his name.

The penury of wooden sleepers after the world war 1914/1918 had shown with acuteness that it was to the interest of the Railway Companies to multiply their sources of supply of sleepers and to guard against the uncertainties of the wood market by appealing to the reinforced concrete. Among the many sleepers that appeared at that time, only the reinforced concrete sleeper of the Vagneux system is still in use, and with success, now for more than 30 years without interruption.

The reinforced concrete sleeper of the VAGNEUX system is well known. It is a composite sleeper, made

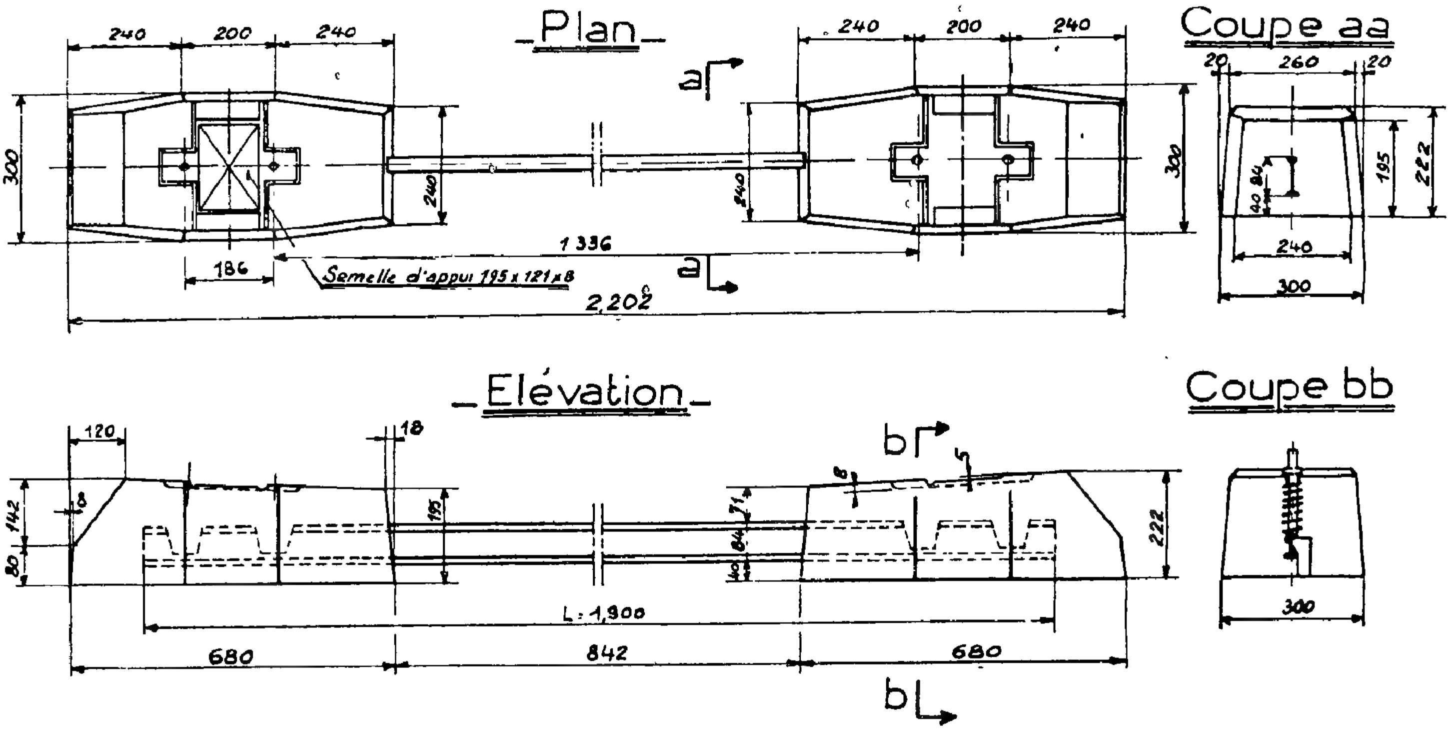


Fig. 1.

up of two blocks of reinforced concrete united by a metal cross-beam, either steel beam I section, or a piece of an old rail, or even an old rail relaminated.

Moreover, in 1954 the SOCIETE DE TRAVERSES EN BETON ARME SYSTEM VAGNEUX has taken out a patent for a sleeper of the same type, but with axial fastening device.

This sleeper (Fig. I.), like the reinforced concrete sleeper of the VAGNEUX system manufactured since the beginning, is built up by means of a metallic cross-beam uniting two blocks or sleeper heads, of reinforced concrete. However, in this sleeper with axial fastenings the cross-beam is a laminated iron with a special bulbous cross-section instead of the beam I PN 80/42.

Besides, the fastenings are situated in the longitudinal axis of the sleeper, two fastenings on each head, placed on each side of the rail.

Like all the VAGNEUX sleepers, these sleepers with axial fastenings can receive any one of the three types of fastening most commonly used at present by the French National Railroads for the equipment of the reinforced concrete sleepers of the Vagneux system, the prestressed concrete sleepers and the longitudinal stringers which they utilize:

(a) Fastening consisting of a coach-screw SC, coated with the special Maille putty and screwed into the Thiollier fitting forming nut (Fig. II).

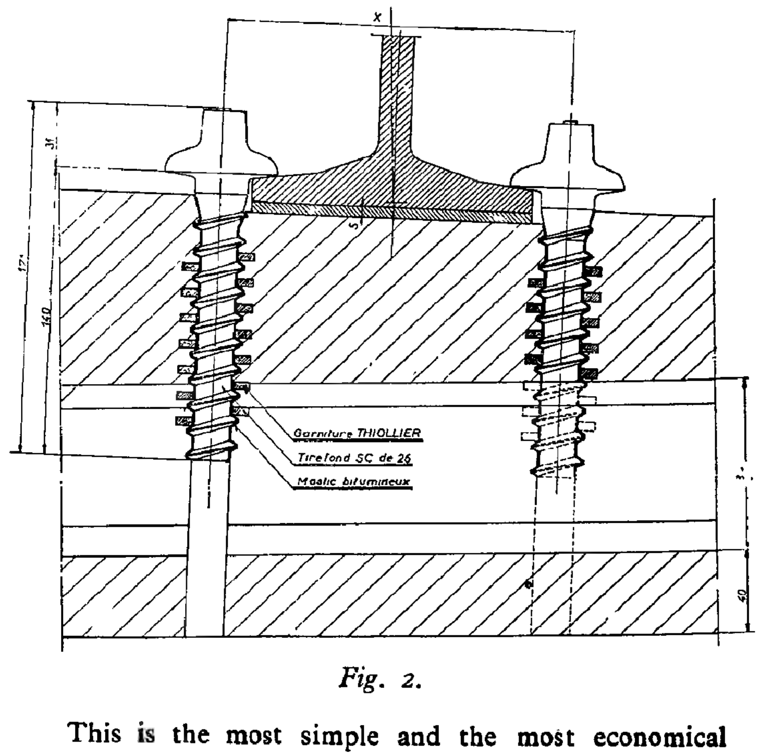


Fig. 2.

This is the most simple and the most economical fastening device.

The fastening is perfectly adapted to tracks with heavy traffic but with moderate speed.

(b) Fastening by means of Vagneux bolt coach-screw and rigid clip, with sole-plate of bakelized wood or metal sole-plate (Fig. III). The Vagneux bolt coach-screw is coated with special putty and screwed into the Thiollier fittings forming nut.

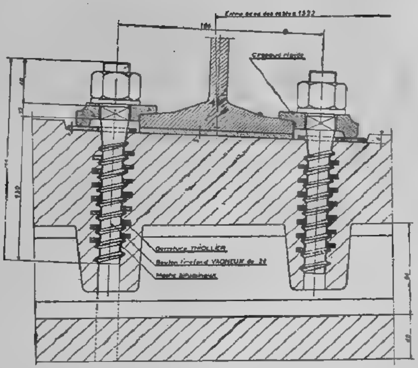


Fig. 3.

The combination of different types of clips permits the realization of various gauges with sleepers of the same drilling (between axises of the fastening holes).

(c) Fastening by means of Vagneux bolt coach-screw and elastic clip, with sole-plate of grooved rubber. (Fig. IV).

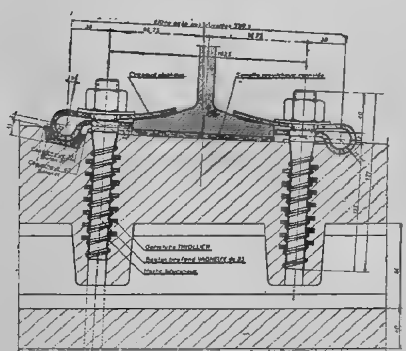


Fig. 4.

The Vagneux bolt coach-screw is coated with a special putty and screwed into the Thiollier fitting forming nut.

These two types of fastening, (b) and (c), are used on modern tracks with heavy and rapid traffic.

The type (c) is particularly suitable to the realisation of tracks with rails welded together forming lengths of more than 900 meters, which is the latest development in the railway technique.

As have been seen above, thanks to the various combinations which are possible with regard to the fastening of the rail, the VAGNEUX reinforced concrete sleeper can be adapted to the track to which it is destined according to the traffic conditions on the line in question.

Thus the Vagneux sleepers are to be found on lines with heavy and rapid traffic (passengers and goods) as well as on lines with slow traffic, as industrial junctions, or on tracks with very heavy traffic as harbour lines, coal mines, etc.

The two latter types of track supporting a relatively slow traffic can also be equipped with pairs of blocks not united with a metal cross-beam, alternating with ordinary sleepers. This reduces considerably the cost price of the track in question.

The Vagneux sleeper is thus characterized by this suppleness in adaption to the traffic conditions that the track has to ensure.

To sum up, in addition to the qualities of resistance proved by the wide use of the Vagneux reinforced concrete sleeper made by the French National Railway Society (more than 2,500,000 sleepers in service, some of them since 1930 and still satisfactory), the following particularly interesting advantages are to be mentioned :

— Suppleness in adaption to the traffic conditions.

— Possibility of equipping without difference with any one of the three principal types of fastening used at present:

(1) ordinary coach-screw,

(2) Vagneux bolt coach-screw with rigid clip,

(3) Vagneux bolt coach-screw with elastic clip.

— A very reduced maintenance requiring only a minimum of labour.

— Absolute resistance against atmospheric agents, and against parasites, termites, etc.

— Possibility of manufacturing on the spot, either in an important centre or on a movable working place near the place of utilisation. The simple conception of the Vagneux sleeper permits a fabrication that needs only a small proportion of highly skilled labour thanks to the use of a material containing all the latest improvements, manufactured by the SOCIETE DE TRAVERSES EN BETON ARME SYSTEM VAGNEUX in their own factory at Persan (Seine & Oise), France.

At the present time, when great efforts are made, or are going to be made, in the railway service in all countries, either in renovating or in completing the public or private lines it is of importance to lay a great stress upon the advantages offered by the VAGNEUX sleeper, by far the most economical sleeper, because the best adaptable to the various subjections of the traffic and because it has the most important references.

These considerations have not escaped from the attention of the technicians and railway owners who are studying the development and the modernisation of the substructure of their railway system basing their calculations on the use of reinforced concrete sleepers of the VAGNEUX system.

(Continued from page 54)

parts, such as vestibule doors, window sashes, many kinds of trims etc., were replaced by light alloy. Consequently the inside view of the coaches were much modernized and, at the same time, many accommodations were modified to increase the passenger's comfort. Fig. 17 shows the interior of the coaches.

FREIGHT CAR

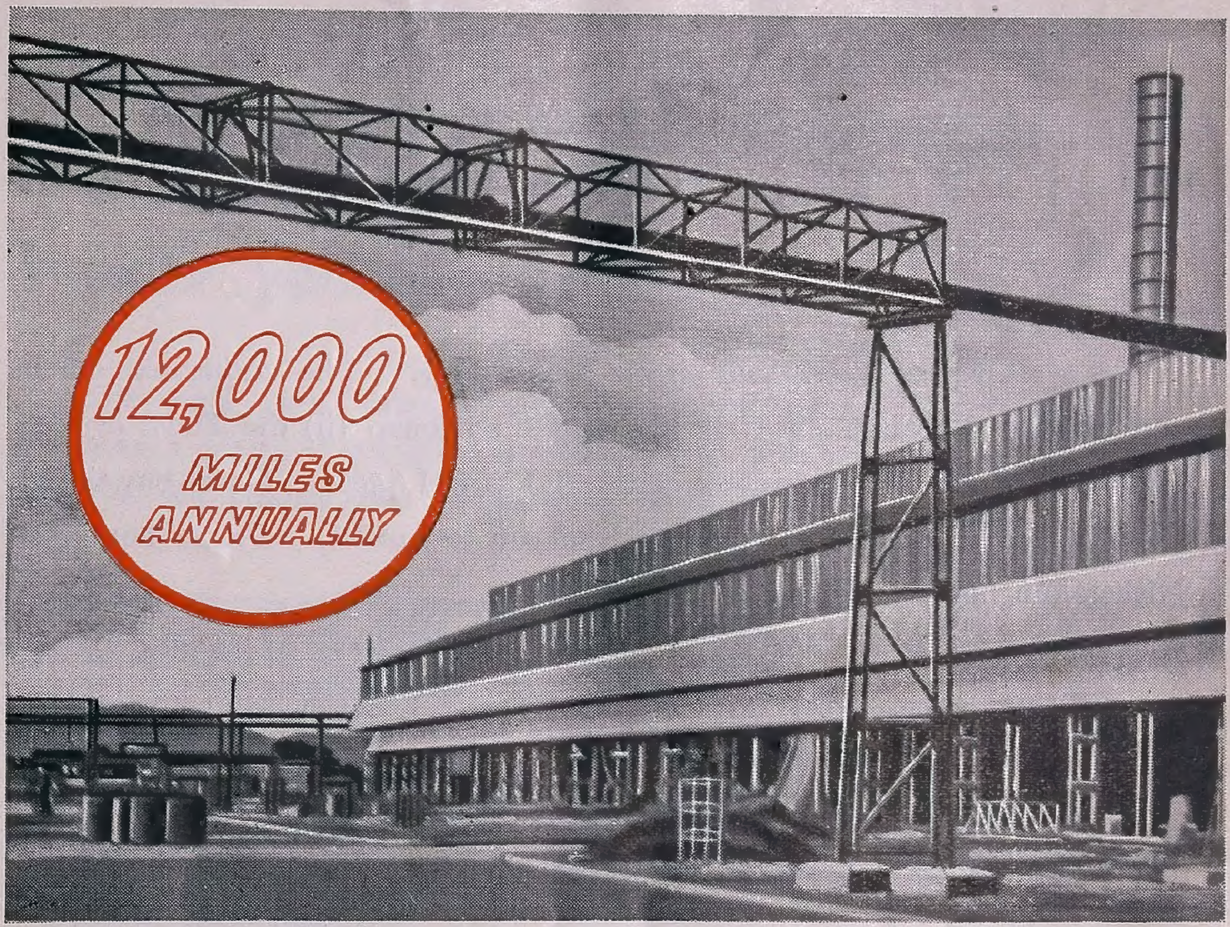
Apart from the conventional wagons, a few examples of the wagons for special purposes are shown in the illustrations. Those special wagons have rapidly increased in Japan in the recent years.

Fig. 18 shows a cement nopper car supplied to Nippon Semento Kaisha (Japan Cement Co.). Cement is discharged from the bottom by means of compressed air, which can be operated from the locomotive cab in the train. Fig. 19 shows a tank car for liquid chlorine. The tank and its mountings, such as inlet and discharge valves, safety valves etc., are carefully designed and manufactured for handling dangerous content of high pressure. Besides above tank car, there can be seen many kinds of special tank cars for carrying liquid ammonium, liquid propane, caustic soda, sulphuric acid, etc. in Japan.

RAIL CONCESSIONS FOR TWO MONTHS—TERMS OF CONCESSION ANNOUNCED

As announced by the Railway Minister while presenting the Railway Budget for 1956-57, it has been decided that concessional return ticket at one and a half single journey fares should be issued on all the Railways from July 15 to September 15, 1956 for Classes I, II and III. Return tickets will be issued only between stations which are situated at a minimum distance of over 300 miles from each other. Break of journey on the return journey will not be permitted,but it will be allowed on the outward journey according to the normal rules applying in the case of single journey tickets.

Passengers must present the return halves of their tickets at the booking office of the station from which the return journey is commenced, and have these dated, indicating the date of commencement of the return journey. This is important, as passengers holding return halves which are not so dated will be treated as ticketless travellers. For journeys between 301 and 500 miles the period of availability of the return tickets will be 20 days; between 501 and 750 miles it will be 25 days; and for journeys of 751 miles and over the period of availability will be 30 days. However, the return tickets will not be valid for the completion of the return journey after the midnight of September 30, 1956. For example, a return ticket issued for a distance over 750 miles on September 14, will be available for completion of the return journey only up to September 30, 1956.



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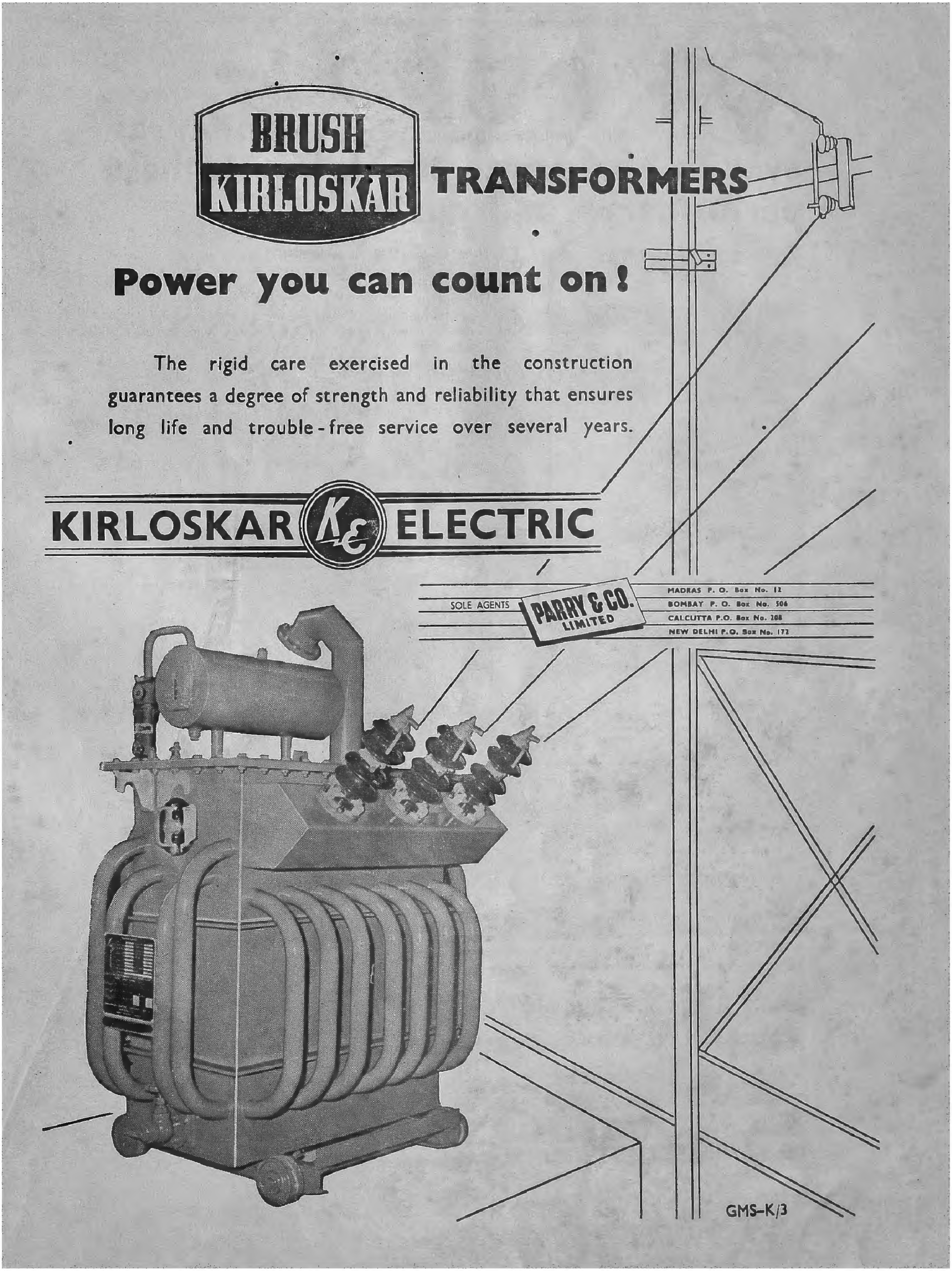
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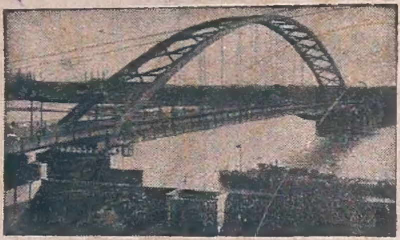

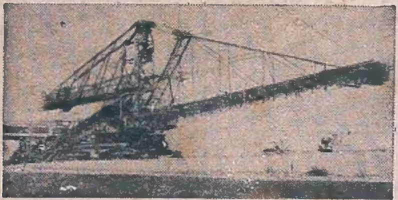

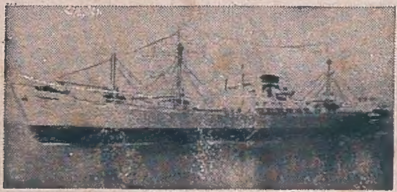

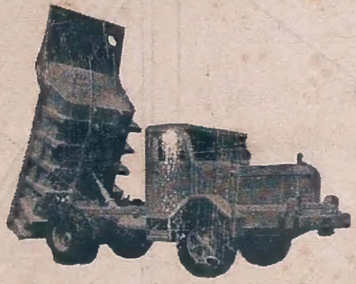

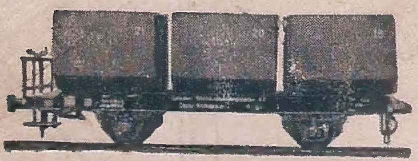

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